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U S NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO 1138

FRAGMENTATION CHARACTERISTICS

23rd Partial Report

FRAGMENTATION TESTS OF NOTCHED-RING BOMBS, 250 LB, TYPE EX 17 MOD 0

FINAL Report

Copy No. 10

Task Assignment NPG-Re3d-418-1-53

Classification CONFIDENTIAL SECURITY INFORMATION

NPG REPORT NO. 1138

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod C

PART A

SYNOPSIS

1. This test was conducted to determine the fragmentation characteristics of 5 lots of 250 lb. Ring Bombs, Type Ex 17 Mod 0, Composition B loaded, and having wrapped 3/8" square wire cases manufactured as follows:

a. 130,000 T.S. steel, 0".050 deep internal notches, Lot 1

b. 102,000 T.S. steel, 0".050 deep internal notches, Lot 2

c. 102,000 T.S. steel, 0".025 deep external notches, Lot 3

d. 102,000 T.S. steel, 0".025 deep side notches, Lot 4

e. 102,000 T.S. steel with no notches, Lot 5

2. a. The methods employed for controlling fragment size in Bomb Lots 1 to 4 were unsatisfactory, as could have been predicted before the test.

b. The median beam spray, zone 55°-120°, fragment velocity was in the order of 5650 ft/sec for all bomb lots.

c. Bomb Lots 1 and 2 produced about 20% more fragment hits at 60' than Lots 3, 4, and 5. This, in effect, indicates finer fragmentation for Lots 1 and 2. Approximately 80% of the effective fragment hits from all bombs were in polar zone 85°-105°.

d. Peak blast pressures at 50' for all bomb lots averaged 7.4 psi.

3. a. In order to obtain better fragment size control it is recommended that (1) notch depths be increased to at least 50% of the wire thickness, (2) internal notches be used, and (3) wire in the neighborhood of 100,000 psi tensile strength be used for the Ex 17 Mod 0 Bomb.

b. Consultations with the Naval Proving Ground and the Naval Ordnance Laboratory are also recommended before any more designs of controlled fragmentation bombs are contracted for by the Bureau of Ordnance.

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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PART B

INTRODUCTION

1. AUTHORITY:

This test was authorized by references (a) and (b) and conducted under Task Assignment NPG-Re3d-418-1-53, reference (c).

2. REFERENCES:

a. BUORD Conf ltr NP9 Re3d-Re3c-LME,ANB:bc Ser 48430 of 1 December 1952
b. BUORD Conf ltr NP9 Re3d-ANB:hjk Ser 49797 of 30 December 1952
c. BUORD ltr NP9 Re3d-ANB:bc of 29 July 1952
d. Chamberlain Corp Conf ltr to BUORD (Re3c) of 30 October 1952
e. NMD Yorktown Conf ltr X24/X0 (Gt 3) WFS:jes Ser 049 of 27 January 1953
f. NPG Conf Report No. 957 of 1 May 1952

3. BACKGROUND:

In the development of a 250 lb. low drag fragmentation bomb, the Chamberlain Corporation at Waterloo, Iowa was requested to manufacture five (5) lots of ring bombs, all having the same external contours but varying in types of steel and notching methods, in an effort to control fragment size.

4. OBJECT OF TEST:

This test was conducted to determine the fragmentation characteristics of 5 lots of 250 lb. Ring Bombs, Type Ex 17 Mod 0, Composition B loaded, and having wrapped 3/8" square wire cases manufactured as follows:

a. 130,000 T.S. steel, 0"050 deep internal notches, Lot 1

b. 102,000 T.S. steel, 0"050 deep internal notches, Lot 2

c. 102,000 T.S. steel, 0"025 deep external notches, Lot 3

d. 102,000 T.S. steel, 0"025 deep side notches, Lot 4

e. 102,000 T.S. steel with no notches, Lot 5

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 18 Mod 0

5. PERIOD OF TEST:

a.	Dates Project Letters	1 December 1952 30 December 1952
b.	Date Necessary Material Received	16 February 1953
c.	Date Commenced Test	5 March 1953
d.	Date Test Completed	30 April 1953

6. REPRESENTATIVES PRESENT:

This test was witnessed in part by Messrs. F. D. Donoghue and R. F. Grott representing the Bureau of Ordnance.

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. Five (5) lots of 250 lb. Ring Bombs Type Ex 17 Mod 0, Composition B loaded, with cases made according to Figures 2 to 6, inclusive, by the Chamberlain Corporation, Waterloo, Iowa. The essential physical data for the 5 lots of bomb cases obtained from reference (d) are as follows:

Lot No.	Case Material (SAE)	T.S. (psi)	Elong (in 2")	R.A.	Hardness Rockwell "B"	Notch Location	Notch Depth
1	1038	130,000	8.5%	22.9%		internal	0.050
2	1038	102,500	12.5%	53.0%	97-98	internal	0.050
3	1038	102,500	12.5%	53.0%	97-98	external	0.025
4	1038	102,500	12.5%	53.0%	97-98	* side	0.025
5	1038	102,500	12.5%	53.0%	97-98	plain wire, no notches	

* The "side" notches are diametrically opposite and wound with notches fore and aft to bomb body.

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
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All Notch spacings were 3/8" from center to center.

All bombs had 1/16" thick steel inner liners. The bomb and explosive weights reported by Naval Mine Depot, Yorktown, Virginia, in reference (e) with fuze and boosters weights are as follows:

Bomb Ser No.	Bomb Lot No.	Bomb Case weight ±0.015 lb.	Hot melt weight ±0.03 lb.	Comp B weight ±0.03 lb.	Wax Filler weight ±0.03 lb.	Nose fuse wt.lbs.	Fuse booster wt.lbs.	Total weight lbs.
1	1	141.22	4.16	91.17	0.13	2.85	0.70	240.23
2	1	141.81	3.75	92.14	0.11	2.85	0.70	241.36
4	2	143.63	3.40	93.27	0.16	2.85	0.70	244.01
5	2	143.92	4.17	91.49	0.25	2.85	0.70	243.38
6	2	145.44	3.93	92.46	0.16	2.85	0.70	245.54
7	3	145.16	4.04	92.02	0.09	2.85	0.70	244.86
8	3	148.33	4.13	91.80	0.09	2.85	0.70	247.90
9	3	148.63	4.54	91.18	0.14	2.85	0.70	248.04
10	4	143.75	4.13	92.29	0.13	2.85	0.70	243.85
11	4	147.16	4.54	91.26	0.11	2.85	0.70	246.62
12	4	145.53	4.05	91.48	0.19	2.85	0.70	244.80
13	5	148.42	4.37	91.30	0.06	2.85	0.70	247.70
14	5	148.45	3.89	91.28	0.11	2.85	0.70	247.28
15	5	149.31	3.94	93.12	0.16	2.85	0.70	250.08
16	5	148.30	4.27	92.24	0.16	2.85	0.70	248.52
17	5	148.16	4.26	92.22	0.14	2.85	0.70	248.33
18	5	149.05	4.18	91.20	0.11	2.85	0.70	248.09

The nose fuzes AN-M103A1 were modified for static detonation by the Naval Ordnance Laboratory, Figure 1. The fuze booster used on all bombs was a cylinder of bare Composition C-3, 2"64 diameter and 2"37 long and placed directly behind the nose fuze. These boosters were formed at the Naval Proving Ground and used to simulate the interim fuze arrangement planned by the Bureau of Ordnance.

b. Each bomb case was formed by wrapping a 3/8" square wire about a 1/16" thick steel liner. As computed by the Proving Ground, Lots 1 to 4 were designed by notching to produce 6640 cubical (3/8") fragments weighing 6.33 grams each. The total weight of wire was computed to be 92.66 lbs. No base fuzes were used in this test, and the base fuze cavities were plugged. The Proving Ground noted that two (2) turns of wire on the extreme base end of bombs from Lot 3 were not notched and does not know whether this was intentional or a manufacturing defect.

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

8. PROCEDURE:

a. All bombs, except No. 18 of Lot 5, which was detonated over the Naval Proving Ground Water Pit, were tested in a 60' radius semi-circular space arena having 1/8" mild steel panels 5' high and marked off in 5° polar angle zones. Each bomb was placed horizontally on a wooden stand with its nose pointed toward 0°. Four (4) foot high cane fiberboard packs for sample fragment recovery were placed at a 60' distance on the open arena side in zone 90°-106° and marked off in 4° zones. Three (3) 35mm Fastax cameras were used to obtain fragment velocities. Camera No. 1 viewed zone 55° to 120°, Camera No. 2 viewed zone 120°-180°, and Camera No. 3 viewed zone 0°-55°. Some of the nose fragment velocities were not obtained since their velocities were below 2000 ft/sec. and poor plate flashes are obtained at those velocities. The field set-up is shown in Figure 7.

b. Bomb No. 18 of Lot 5 was detonated over the Naval Proving Ground Water Pit in order to obtain a larger fragment sample. The water pit recovers 1/6 of the total fragments expelled in polar zone 60°-120°. Fragment velocities were also obtained in this test by using 15' high steel panels at a 60' distance in zone 84°-107°. A high speed photograph sequence showing the detonation and fragment flashes on the steel panels is shown in Figure 8.

c. Three (3) Naval Ordnance Laboratory indenter gages were placed at 50 feet from the 60' arena center in zone 135° on the open arena side to record peak blast pressures.

9. RESULTS AND DISCUSSION:

a. Fragment Space Distribution

The detailed space data are listed in Tables I to V inclusive. Fragment hits are those which penetrated the 1/8" mild steel panels. The main concentration of fragment hits were in polar zone 80° to 150°. The distributions are as follows:

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

Polar Zone	Hits per Total Zone				
	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
0°-65°	67	147	60	121	81
65°-80°	880	769	440	698	610
80°-85°	700	700	750	430	700
85°-90°	1510	1183	980	882	1010
90°-95°	2000	1808	1130	1077	1296
95°-100°	3480	4240	3760	3570	2980
100°-105°	1620	1303	1494	1421	1016
105°-180°	180	369	99	214	260
Totals	10,437	10,519	8,713	8,413	7,953

Polar Zone	% of Total Hits				
	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
0°-65°	0.6	1.4	0.7	1.4	1.0
65°-80°	8.4	7.3	5.1	8.3	7.7
80°-85°	6.7	6.7	8.6	5.1	8.8
85°-90°	14.5	11.2	11.2	10.5	12.7
90°-95°	19.2	17.2	13.0	12.8	16.3
95°-100°	33.4	40.3	43.2	42.4	37.5
100°-105°	15.5	12.4	17.1	16.9	12.8
105°-180°	1.2	3.5	1.1	2.6	3.2
Totals	100.0	100.0	100.0	100.0	100.0

b. Fragment Plate Penetrations

From the field observations on ricochet fence plates at 30', arena panels at 60', and velocity panels at 60' by the Water Pit, general statements on the penetration at 0° obliquity of these bomb fragments in zone 80°-105° can be made:

(1) The majority will make 1/2" diameter holes in 1/8" mild steel plate

(2) about 33% will penetrate 5/8" thick STS plate at 30 feet

(3) about 8% will penetrate 5/8" thick STS plate at 60 feet

(4) none will penetrate 3/4" thick STS plate at 30 feet.

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

c. Fragment Velocities

The detailed fragment velocities of the seventeen (17) bombs are listed in Tables VI to X inclusive, and are summarized as follows:

Bomb Portion	Zone	Average Median Fragment Velocities (ft./sec.) Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
Nose	0°-15°	*1720	1730	1730	1780	1660
Beam	55°-120°	5520	5670	5790	5610	5600
Base	165°-180°	4430	4680	4600	4200	4290

* estimated.

None of the variations in fragment velocities are regarded as significant.

d. Fragment Mass Distribution

(1) Sample fragments recovered in zone 90°-106° from the 4' high cane fiberboard packs at 60' are shown in Figures 9 to 14, inclusive. The numbers and weights listed and averaged are tabulated in Table XI. The water pit recovery of Bomb Serial No. 18 of Lot 5, 1/6 of total expected in zone 60°-120°, is shown in Figure 15 and are listed in Table XI. The mass data are summarized as follows:

	Average No. Fragments Recovered in Zone 90°-106°								Total
Bomb Lot	5/8-1.25 grams	1.25-2.5 grams	2.5-3.5 grams	3.5-4.5 grams	4.5-5.5 grams	5.5-6.5 grams	6.5-7.5 grams	7.5-21.0 grams	5/8-21.0 grams
1	28	34	21	33	4	15	14	1	*148
2	26	21	16	17	3	9	24	2	118
3	13	29	16	19	7	20	22	1	127
4	21	22	10	17	16	18	9	4	116
5	20	14	8	11	10	10	10	15	98
**5	407	231	187	222	209	173	107	230	1766

* The 148 total is a more accurate figure than the 150 total obtained when the average individual groups are added.

** Recovered from Naval Proving Ground Water Pit on Bomb Serial No. 18. The numbers represent 1/6 of the total expected in zone 60°-120°.

(2) Although the cane fiberboard recovery represents only a small portion of the total expected fragments the average numbers of Lot 5 are proportional to those recovered over the water pit. The water pit total of 1-1/4 to 21 gram fragments, 1359 multiplied by 6, is 8154. This figure agrees very well with the average number of fragments penetrating the 1/8" mild steel plate in the space distribution tests, 7794, in zone 60°-120° (Table V).

(3) To evaluate the degree of control of fragment size obtained, a fair criterion is the total number of fragments of design size or larger as compared with the same quantity for the uncontrolled fragmenter. The design size for the subject bombs, as stated above, was 6.3 grams. The following table shows that even if allowance is made for a substantial degree of chipping of the design-size fragments, the "controlled" designs offer no advantage over the uncontrolled.

Average Number of Recovered Fragments with Mass greater than m

m	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
4.5	34	38	50	47	45
5.5	30	35	43	31	35
6.5	15	26	23	13	25
7.5	1	2	1	4	15

Previous experience has shown that shallow notches of the types employed in these bombs are of no value in producing equi-axed fragments. A notch at least half way through the wire would be required for satisfactory control.

e. Blast Data

The average peak blast pressures recorded by the Naval Ordnance Laboratory indenter gages at 50' from the bombs in zone 135° are as follows:

Bomb Lot	Peak Pressure (psi at 50')
1	7.3
2	7.4
3	7.7
4	7.5
5	7.0

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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There were no significant pressure differences between bomb lots. The pressure variation within bomb lots was ±0.9 psi. Reference (f) reported fragmentation and blast data for the 250 lb. Ex 2 Mod 0 Low Drag and the 250 lb. G.P. Standard AN-M57A1 bombs. Their blast pressures are listed for comparison:

Bomb	Filler	Average Filler weight (lbs.)	Average Peak Pressure psi at 50'
Ex 17-0 (Lots 1-5)	Comp B	92	7.4
Ex 2-0 (Low Drag)	80/20 Tritonal	103	8.0
AN-M57A1 (G.P.)	80/20 Tritonal	130	9.3

PART D

CONCLUSIONS

10. a. The methods employed for controlling fragment size in Bomb Lots 1 to 4 were unsatisfactory, as could have been predicted before the test.

b. The median beam spray, zone 55°-120°, fragment velocity was in the order of 5650 ft/sec for all bomb lots.

c. Bomb Lots 1 and 2 produced about 20% more fragment hits at 60' than Lots 3, 4, and 5. This, in effect, indicates finer fragmentation for Lots 1 and 2. Approximately 80% of the effective fragment hits from all bombs, were in polar zone 85°-105°.

d. Peak blast pressures at 50' for all bomb lots averaged 7.4 psi.

PART E

RECOMMENDATIONS

11. a. In order to obtain better fragment size control it is recommended that (1) notch depths be increased to at least 50% of the wire thickness, (2) internal notches be used, and (3) wire in the neighborhood of 100,000 psi tensile strength be used for the Ex 17 Mod 0 Bomb.

b. Consultations with the Naval Proving Ground and the Naval Ordnance Laboratory are also recommended before any more designs of controlled fragmentation bombs are contracted for by the Bureau of Ordnance.

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

The tests upon which this report is based were conducted by:
LT A. N. HUGHES, Fragmentation Firing Officer
Fragmentation Division
Terminal Ballistics Department

This report was prepared by:
V. PHILIPCHUK, Fragmentation Battery Officer
Fragmentation Division
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This test was reviewed by:
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APPROVED: J. F. BYRNE
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By direction

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NPG REPORT NO. 1138

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twenty-third Partial Report

on

Fragmentation Characteristics

- -

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,

Type Ex 17 Mod 0

Project No.: NPG-Re3d-418-1-53
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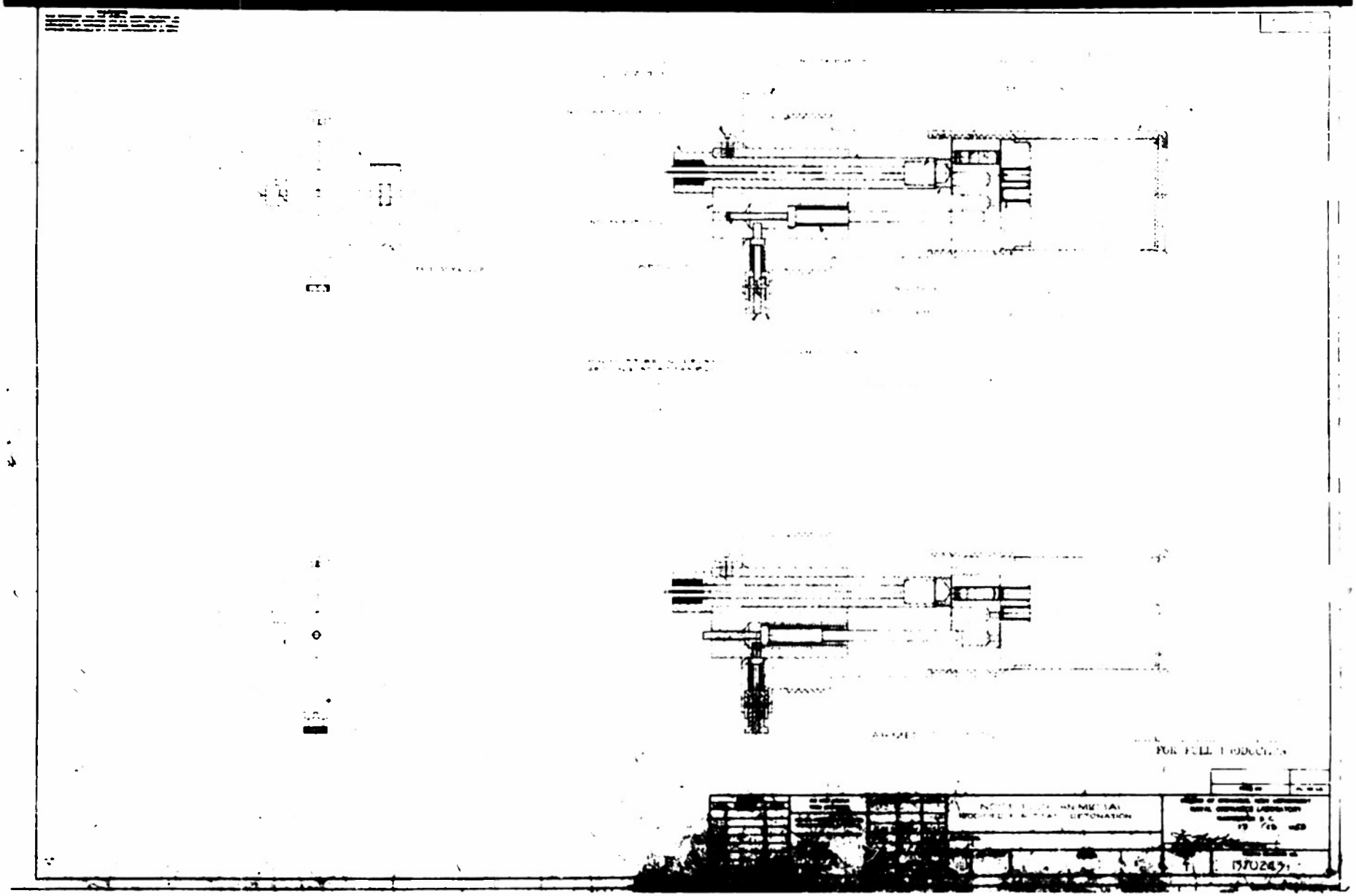

NP9-63267

5 March 1953
250 lb. Bomb Type EX 17 Mod 0 Lot 1
Figure 2

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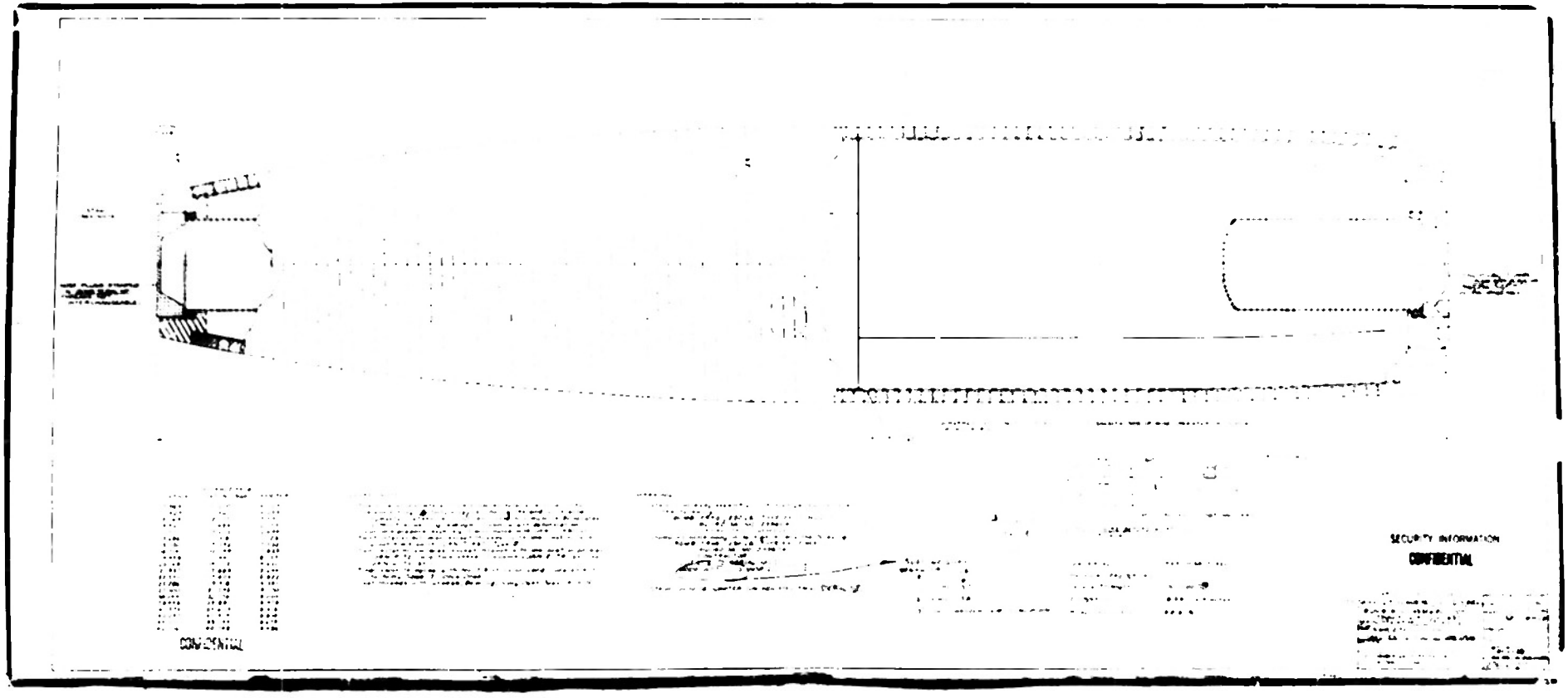

NP9-63268

5 March 1953
250 lb. Bomb Type EX 17 Mod 0 Lot 2
Figure 3

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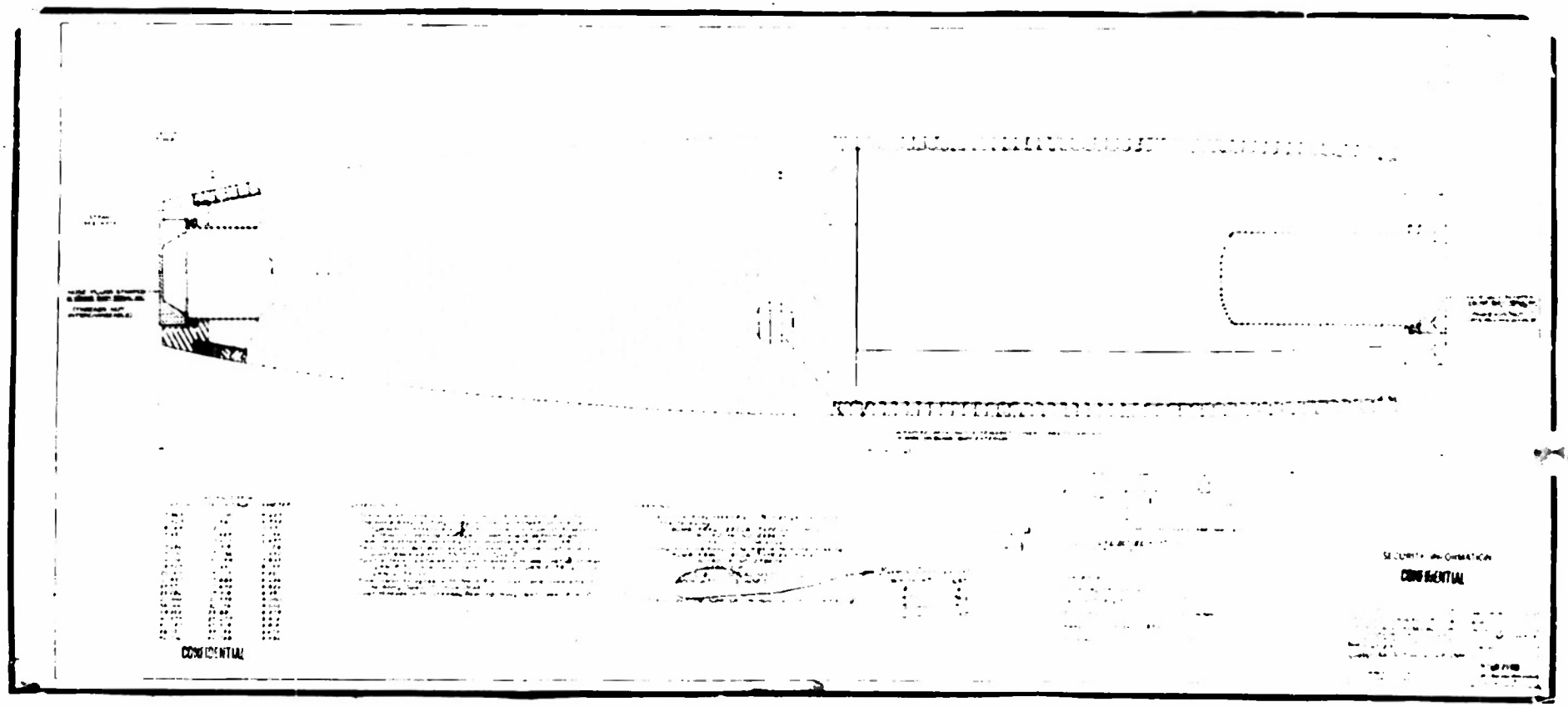

NP9-63269

5 March 1953
250 lb. Bomb Type EX 17 Mod 0 Lot 3
Figure 4

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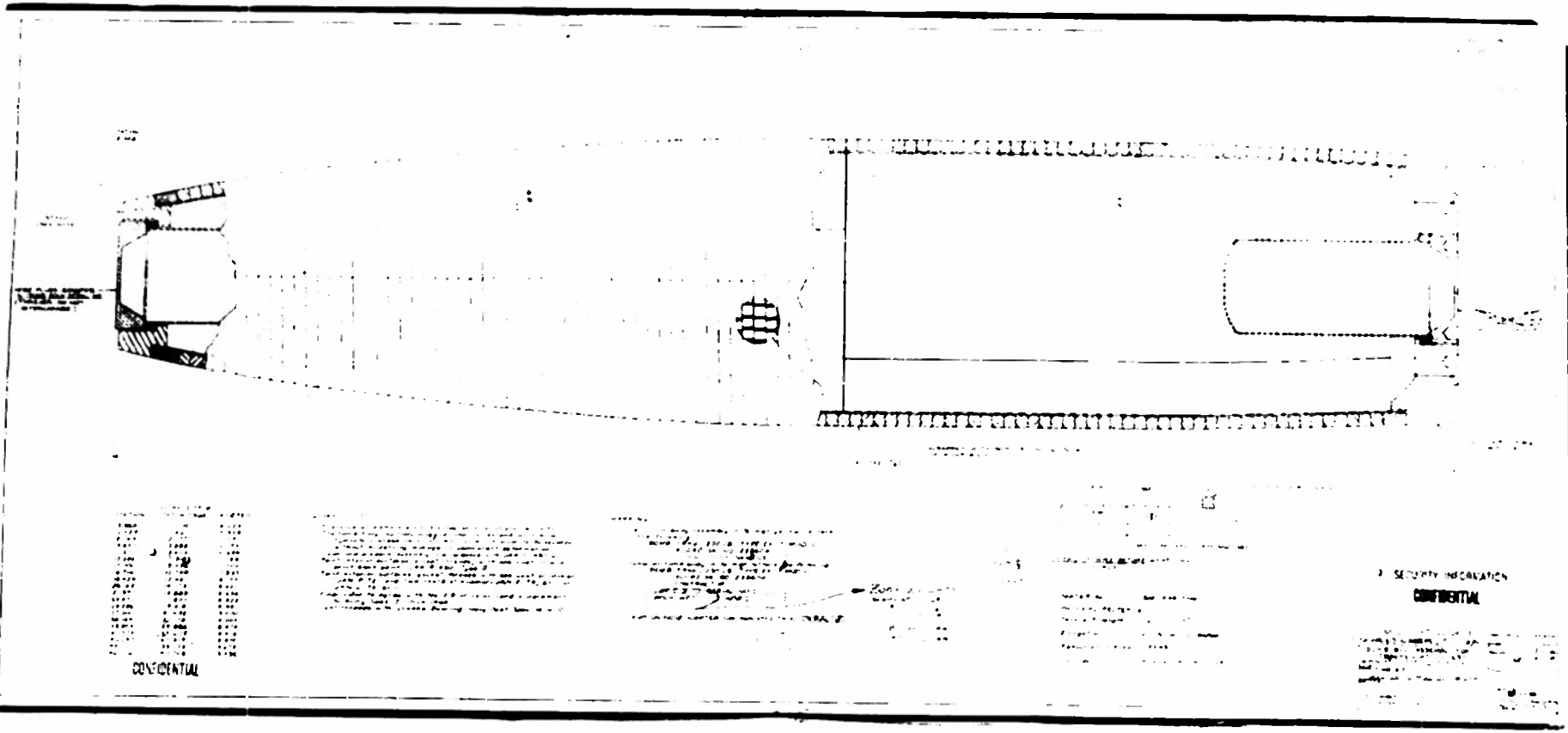

AP9-63270

5 March 1953
250 lb. Bomb Type EX 17 Mod 0 Lot 4
Figure 5

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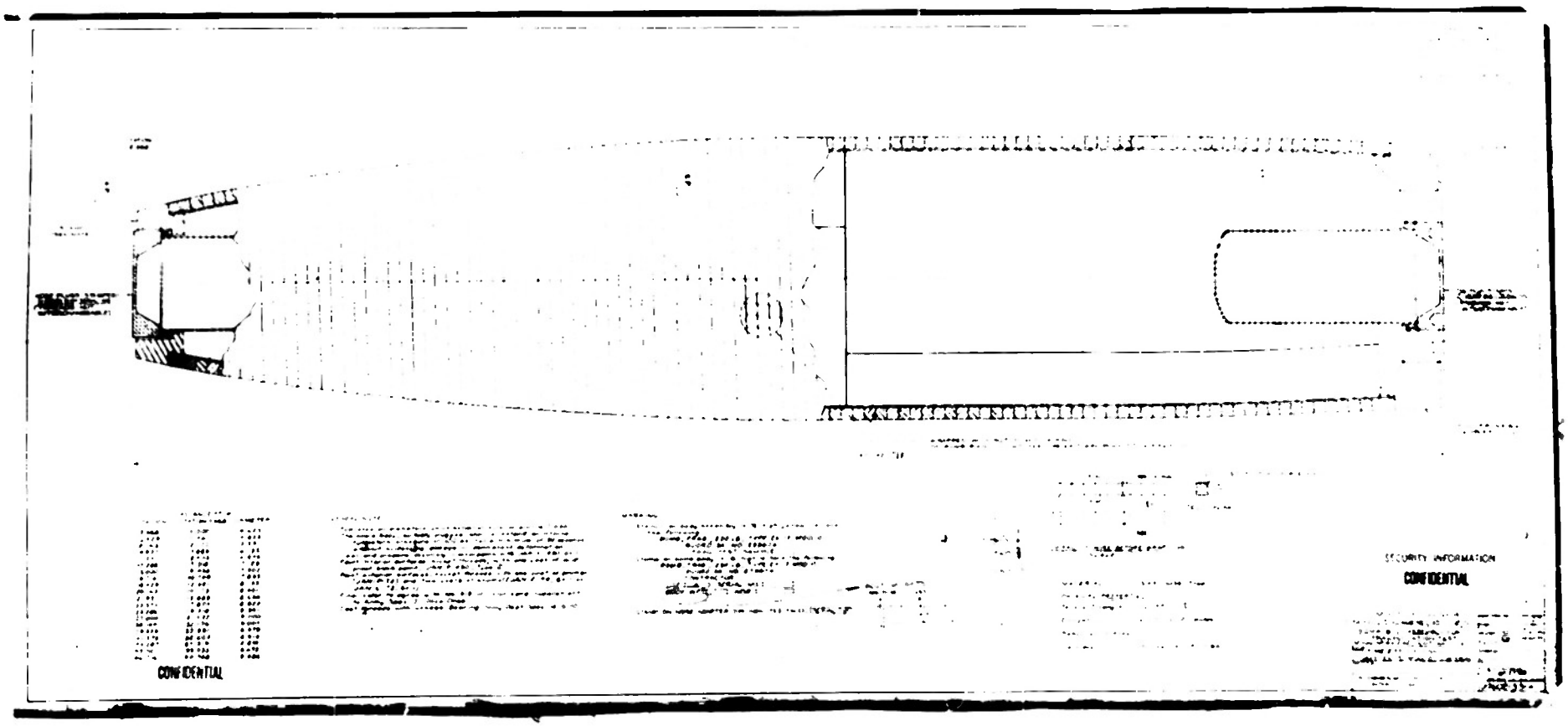

NP9-63271

5 March 1953
250 lb. Bomb Type EX 17 Mod 0 Lot 5
Figure 6

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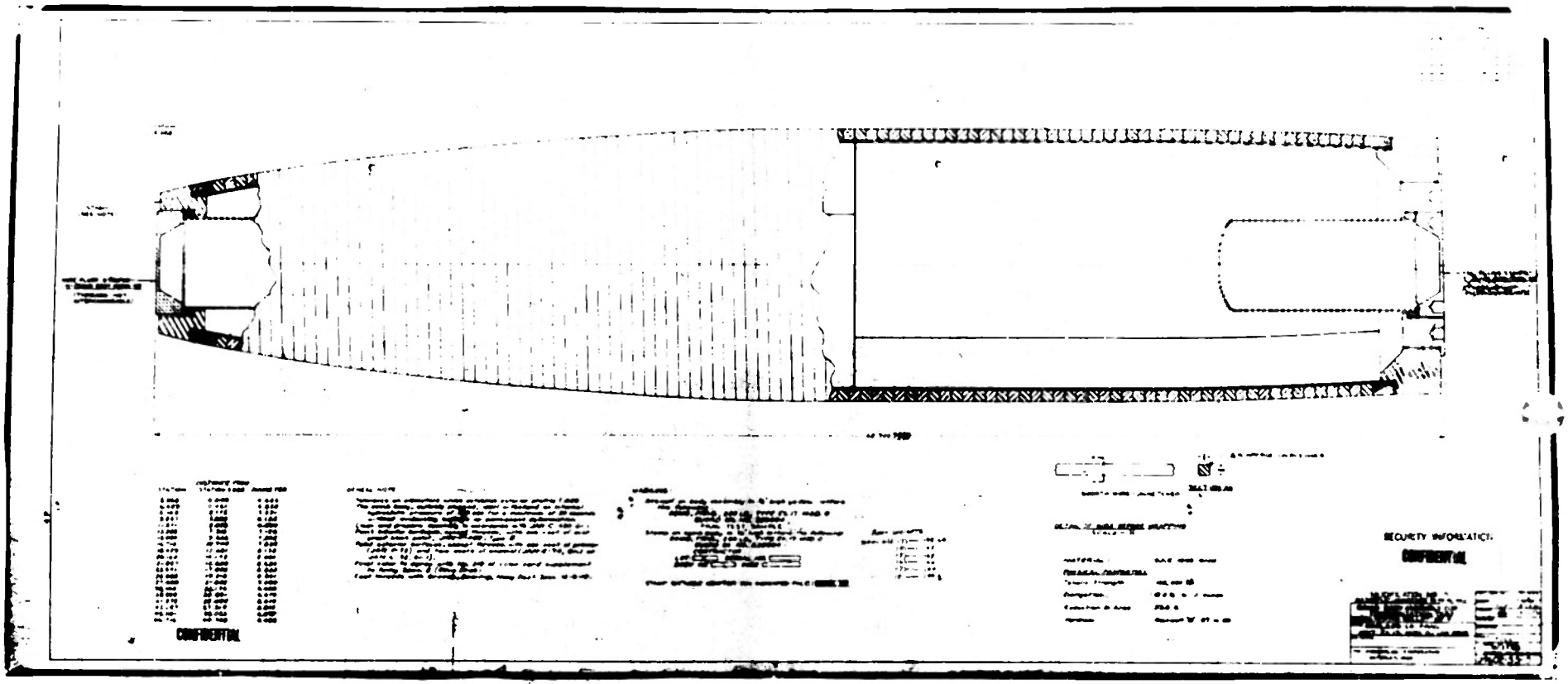

NP9-63272
Field Set up in 60' Radius [redacted] March 1953 for Fragmentation Test of 250 lb. Bomb Type EX 17 Mod 0.
Figure 7

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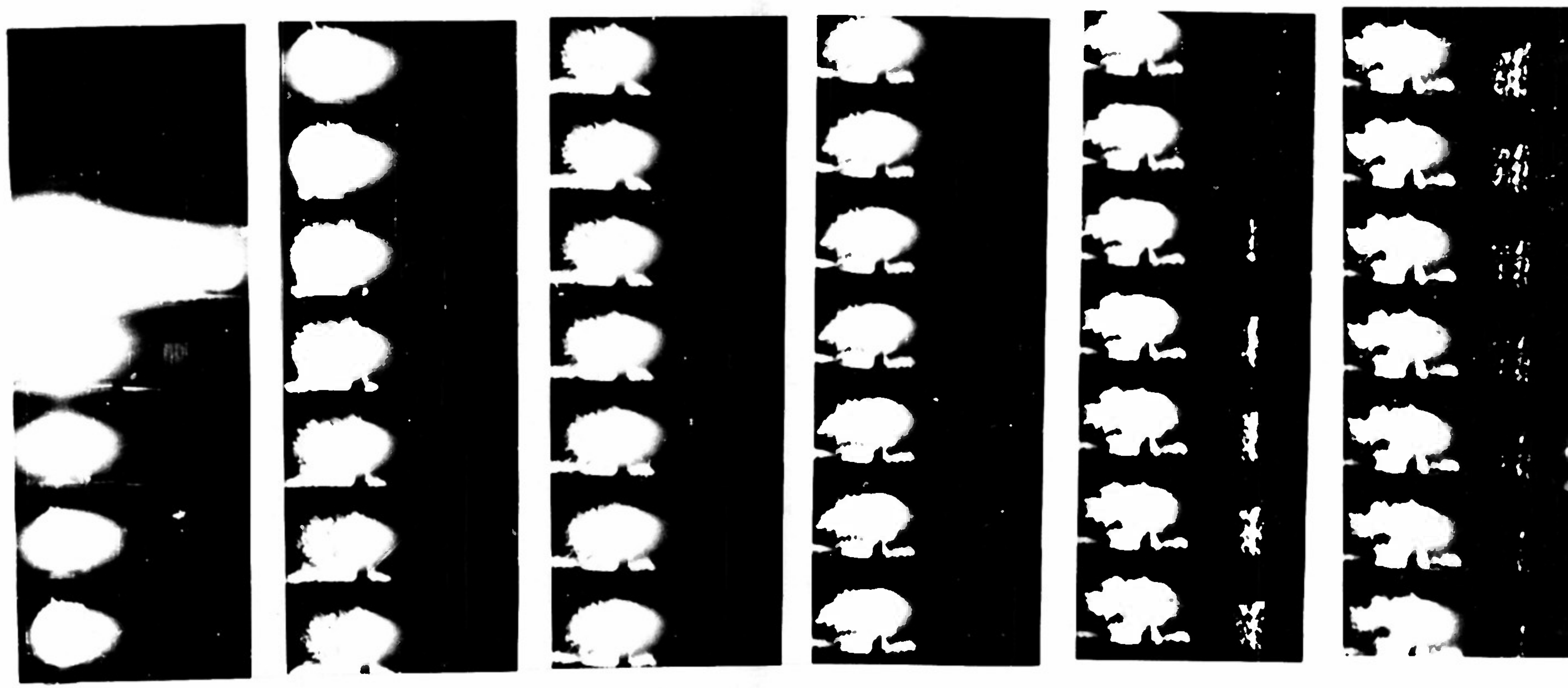
NP9-63273 [illegible] March 19[illegible] SECURITY INFORMATION

High Speed Photo Sequence of [illegible] Type EX [illegible], Serial No. 16, Lot [illegible], Composition B loaded, detonation over [illegible] water [illegible]. [illegible] flashes can be seen on 60' dist[illegible] [illegible] panels.

Figure [illegible]



Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE I

SPACE DISTRIBUTION DATA

250 lb. Bomb Ex 17 Mod 0. Comp B loaded, Lot No. 1

60 ft. Radius Space Arena
1/8" MS panels 5' high

Date:	17 Mar	18 Mar	Average impacts per 5° zone on panel	Average impacts per total 5° zone on panel	Average impacts per unit solid angle
Zone Degrees	Rd. #11 Ser #1	Rd. #13 Ser #2			
0-5	2	2	2.0	7	300
5-10					
10-15					
15-20					
20-25					
25-30					
30-35					
35-40					
40-45					
45-50		1	0.5	30	70
50-55	1		0.5	30	70
55-60					
60-65					
65-70	4	2	3.0	200	400
70-75	3	2	2.5	180	340
75-80	9	5	7.0	500	1000
80-85	8	10	9.0	700	1200
85-90	25	15	20.0	1510	2800
90-95	34	19	26.5	2000	3650
95-100	40	53	46.5	3480	6400
100-105	24	20	22.0	1620	3000
105-110		5	2.5	180	340
110-115					
115-120					
120-125					
125-130					
130-135		1	0.5	30	70
135-140		1	0.5	30	70
140-145	2		1.0	50	140
145-150					
150-155		1	0.5	17	70
155-160					
160-165					
165-170					
170-175	1		0.5	5	70
175-180	9	8	8.5	29	1200

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE II

SPACE DISTRIBUTION DATA

250 lb. Bomb Ex 17 Mod 0. Comp B loaded, Lot No. 2

60 ft. Radius Space Arena
1/8" MS panels 5' high

Date:	17 Mar	19 Mar	20 Mar	Average impacts per 5° zone on panel	Average impacts total 5° zone on panel	Average impacts per unit solid angle
Zone Degrees	Ser #4	Ser #5	Ser #6			
0-5	2	3	2	2.3	7.8	320
5-10		1	1	0.7	7	90
10-15	1		1	0.7	11	100
15-20			1	0.3	7	40
20-25						
25-30						
30-35						
35-40						
40-45						
45-50						
50-55						
55-60						
60-65	2	2	1	1.7	114	230
65-70	3	6	4	4.3	300	590
70-75	3	4	4	3.7	270	510
75-80		7	1	2.7	199	370
80-85	14	7	7	9.3	700	1280
85-90	12	16	19	15.7	1183	2160
90-95	29	21	22	24.0	1808	3300
95-100	60	49	61	56.7	4240	7800
100-105	23	15	15	17.7	1303	2440
105-110	3		4	2.3	165	320
110-115						
115-120		1	2	1.0	70	140
120-125			1	0.3	19	40
125-130						
130-135		1		0.3	17	40
135-140	1		1	0.7	40	100
140-145	1			0.3	14	40
145-150						
150-155						
155-160						
160-165						
165-170			1	0.3	5	40
170-175	2	3	1	2.0	19	300
175-180	6	6	6	6.0	20	800

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE III

SPACE DISTRIBUTION DATA

250 lb. Bomb Ex 17 Mod 0. Comp B loaded, Lot No. 3

60 ft. Radius Space Arena
1/8" MS panels 5' high

Date:	9 Mar	10 Mar	11 Mar	Average impacts per 5° zone on panel	Average impacts total 5° zone on panel	Average impacts per unit solid angle
Zone Degrees	Ser #7	Ser #8	Ser #9			
0-5	2	2	2	2.0	7	300
5-10		1		0.3	3	40
10-15						
15-20						
20-25						
25-30		1		0.3	10	40
30-35						
35-40						
40-45						
45-50						
50-55						
55-60	1		1	0.7	40	100
60-65						
65-70	2	2	1	1.7	118	230
70-75	3	2		1.7	122	230
75-80	4	3	2	3.0	200	400
80-85	12	5	13	10.0	750	1380
85-90	11	16	12	13.0	980	1790
90-95	14	14	17	15.0	1130	2100
95-100	56	55	40	50.3	3760	6920
100-105	18	18	25	20.3	1494	2790
105-110						
110-115						
115-120						
120-125						
125-130			1	0.3	18	40
130-135			1	0.3	17	40
135-140		1		0.3	15	40
140-145						
145-150						
150-155						
155-160						
160-165		1		0.3	7	40
165-170						
170-175	1	4	2	2.3	22	310
175-180	5	5	8	6.0	20	800

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE IV

SPACE DISTRIBUTION DATA

250 lb. Bomb Ex 17 Mod 0. Comp B loaded, Lot No. 4

60 ft. Radius Space Arena
1/8" MS panels 5' high

Date:	9 Mar	10 Mar	11 Mar	Average impacts per 5° zone on panel	Average impacts total 5° zone on panel	Average impacts per unit solid angle
Zone Degrees	Ser #10	Ser #11	Ser #12			
0-5	2	2	2	2.0	7	300
5-10						
10-15						
15-20	1			0.3	7	40
20-25						
25-30						
30-35						
35-40						
40-45						
45-50	1			0.3	17	40
50-55	1	1		0.7	40	100
55-60						
60-65	1	1		0.7	50	100
65-70	3	2	3	2.7	188	370
70-75	2	4	4	3.3	240	450
75-80	4	3	4	3.7	270	510
80-85	4	6	7	5.7	430	780
85-90	5	21	9	11.7	882	1610
90-95	13	20	20	14.3	1077	1967
95-100	50	41	52	47.7	3570	6560
100-105	20	21	17	19.3	1421	2660
105-110		1		0.3	20	40
110-115						
115-120		2		0.7	50	100
120-125	1	1		0.7	40	100
125-130		1	1	0.7	40	100
130-135		1		0.3	17	40
135-140						
140-145		1		0.3	14	40
145-150						
150-155						
155-160						
160-165						
165-170						
170-175	2	1	1	1.3	13	175
175-180	9	6	6	7.0	20	1000

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE V

SPACE DISTRIBUTION DATA

250 lb. Bomb Ex 17 Mod 0. Comp B loaded, Lot No. 5

60 ft. Radius Space Arena
1/8" MS panels 5' high

Date:	5 Mar	5 Mar	6 Mar	Mar	Mar	Average impacts per 5° zone on panel	Average impacts total 5° zone on panel	Average impacts per unit solid angle
Zone Degrees	Ser #13	Ser #14	Ser #15	Ser #16	Ser #17			
0-5	1	2	3	2	3	2.2	7.4	310
5-10			2	1		0.6	6	80
10-15					1	0.2	3	30
15-20								
20-25								
25-30								
30-35					1	0.2	8	30
35-40								
40-45					1	0.2	11	30
45-50			1	1		0.4	20	60
50-55								
55-60		1				0.2	13	30
60-65					1	0.2	13	30
65-70	5	1	3	2	4	3.0	200	400
70-75	1	2		1	1	1.0	70	140
75-80	3	5	7	1	7	4.6	340	630
80-85	8	15	4	10	8	9.0	700	1200
85-90	17	10	16	7	17	13.4	1010	1844
90-95	17	15	21	17	16	17.2	1296	2370
95-100	46	38	42	47	26	39.8	2980	5480
100-105	26	14	4	13	12	13.8	1016	1899
105-110	2	2	1	3	1	1.8	129	250
110-115								
115-120			1		2	0.6	40	80
120-125		1	1	1		0.6	40	80
125-130				1		0.2	12	30
130-135								
135-140		1				0.2	10	30
140-145								
145-150								
150-155								
155-160								
160-165								
165-170								
170-175	1		2			0.6	6	80
175-180	7	6	6	9	6	6.8	23	960

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI

FRAGMENT VELOCITY DATA LOT 1

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 11, 250# Ex 17-0 Ring Bomb Ser. #1
Total Weight 240.23 lbs.

2950 Frames per sec.
Comp. B
Filler Weight 91.17 lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
26	90-95	2	2	6810
27	90-95	2	2	6560
28	90-95	5		
	95-100	7	12	6320
29	90-95	6		
	95-100	4		
	100-105	1	11	6100
30	85-90	3		
	90-95	2		
	95-100	1	6	5900
31	90-95	3		
	95-100	1		
	100-105	5	9	5710
32	85-90	3		
	90-95	2		
	95-100	1		
	100-105	3	9	5530
33	85-90	2		
	90-95	1	3	5360
34	80-85	1		
	85-90	4		
	90-95	2		
	100-105	3	10	5210
35	75-80	1		
	80-85	2		
	85-90	1		
	95-100	2		
	100-105	1	7	5060
36	75-80	2		
	80-85	2		
	100-105	1	5	4920

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
37	70-75	2		
	75-80	2		
	80-85	1		
	85-90	1		
	90-95	1	7	4780
38	70-75	1		
	75-80	1	2	4660
40	95-100	1		
	70-75	1	2	4430
43	65-70	1	1	4120
44	90-95	1	1	4020
45	100-105	2	2	3930
47	65-70	1	1	3770
Median				5600
Average				5500

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 11, 250# Ex 17-0 Ring Bomb Ser. #1
Total Weight 240.23 lbs.
3050 Frames per sec.
Comp. B
Filler Weight 91.17 lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
25	175-180	1	1	7320
26	170-175	1	1	7040
28	175-180	3	3	6540
29	175-180	2	2	6310
30	175-180	1	1	6100
31	175-180	2	2	5900
32	175-180	1	1	5720
34	175-180	2	2	5380
35	175-180	1	1	5230
36	175-180	2	2	5080
43	170-175	2		
	175-180	1	3	4260
47	175-180	1	1	3890
49	175-180	1	1	3730
58	165-170	1	1	3160
60	170-175	1	1	3050
63	160-165	1	1	2900
64	165-170	1	1	2860
68	175-180	1 (Base Plug)	1	2690
69	175-180	2	2	2650
71	175-180	2	2	2580
Median				5010
Average				4730

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 13, 250# Ex 17-0 Ring Bomb Ser. #2
Total Weight 241.36 lbs.

3050 Frames per sec.
Comp. B
Filler Weight 92.14 lbs.
Date: 18 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	95-100	2	2	6540
29	95-100	6	6	6310
30	90-95	3		
	95-100	5	8	6100
31	90-95	2		
	95-100	6		
	100-105	1	9	5900
32	85-90	2		
	90-95	3		
	95-100	1	6	5720
33	85-90	2		
	90-95	1		
	100-105	2	5	5550
34	85-90	3		
	90-95	2		
	100-105	1	6	5380
35	80-85	2		
	85-90	2		
	95-100	2		
	100-105	2	8	5230
36	80-85	1		
	85-90	1		
	100-105	2	4	5080
37	80-85	3		
	90-95	1		
	95-100	1		
	105-110	1	6	4950
38	75-80	1		
	80-85	2		
	105-110	1	4	4820

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
39	70-75	1		
	90-95	1		
	95-100	1	3	4690
40	75-80	1		
	80-85	2		
	90-95	1		
	105-110	1	5	4580
41	70-75	1		
	75-80	2		
	80-85	1		
	90-95	1	5	4460
44	70-75	1	1	4160
45	90-95	1	1	4070
48	80-85	1		
	100-105	1	2	3810
49	100-105	1	1	3730
Median				5440
Average				5330

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VI (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 13, 250# Ex 17-0 Ring Bomb Ser. #2
Total Weight 241.36 lbs.

3150 Frames per sec.
Comp. B
Filler Weight 92.14 lbs.
Date: 18 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
26	175-180	1	7270
27	175-180	1	7000
29	175-180	1	6520
33	175-180	3	5730
34	175-180	1	5560
36	175-180	1	5250
40	175-180	1	4730
45	175-180	1	4200
47	175-180	2	4020
48	175-180	1	3940
49	175-180	1	3860
54	175-180	1	3500
57	175-180	1	3320
58	165-170	1	3260
68	165-170	1	2780
71	175-180	3 (Base Plug)	2660
72	175-180	3	2630
73	175-180	2	2590
75	175-180	1	2520
Median			3850
Average			4070

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII

FRAGMENT VELOCITY DATA LOT 2

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 12, 250# Ex 17-0 Ring Bomb Ser. #4
Total Weight 244.01 Lbs.

2950 Frames per sec.
Comp. B
Filler Weight 93.27 Lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
29	95-100	4	4	6100
30	90-95	7		
	95-100	8		
	100-105	1	16	5900
31	90-95	4		
	95-100	2		
	100-105	1	7	5710
32	85-90	1		
	90-95	3		
	100-105	2	6	5530
33	85-90	2		
	90-95	1		
	100-105	5	8	5360
34	85-90	1	1	5210
35	80-85	2		
	85-90	3		
	90-95	2		
	95-100	1		
	100-105	5	13	5060
36	80-85	2		
	90-95	1	3	4920
37	80-85	2		
	105-110	1	3	4780
38	90-95	1		
	95-100	1	2	4660
39	80-85	1		
	90-95	2		
	95-100	1	4	4540
40	80-85	1	1	4430
41	70-75	1		
	90-95	2	3	4320

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE VII (Continued)

Frame in Which Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
42	100-105	2	2	4210
43	65-70	1		
	70-75	1		
	95-100	1	3	4120
46	90-95	1	1	3850
47	65-70	1	1	3770
Median				5400
Average				5230

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 12, 250# Ex 17-0 Ring Bomb Ser. #4
Total Weight 244.01 Lbs.

3150 Frames per sec.
Comp. B
Filler Weight 93.27 Lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
25	175-180	1	1	7560
29	175-180	1	1	6520
31	165-170	1		
	175-180	2	3	6100
32	175-180	1	1	5910
33	170-175	1	1	5730
34	175-180	1	1	5560
35	175-180	1	1	5400
36	175-180	1	1	5250
37	175-180	2	2	5110
39	175-180	1	1	4850
40	170-175	1	1	4730
45	175-180	1	1	4200
50	175-180	2	2	3780
60	155-160	1	1	3150
69	175-180	1 (Base Plug)	1	2740
70	175-180	1	1	2700
71	175-180	1	1	2660
Median				5220
Average				4910

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 14, 250# Ex 17-0 Ring Bomb Ser. #5
Total Weight 243.38 Lbs.

3150 Frames per sec.
Comp. B
Filler Weight 91.49 Lbs.
Date: 19 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	90-95	2		
	95-100	10	12	6750
29	90-95	3		
	95-100	6	9	6520
30	85-90	1		
	90-95	6		
	95-100	2		
	100-105	1	10	6300
31	85-90	2		
	90-95	1		
	95-100	1		
	100-105	2	6	6100
32	85-90	2		
	100-105	1	3	5910
33	85-90	2		
	100-105	1	3	5730
34	80-85	1		
	85-90	4		
	95-100	2		
	100-105	2	9	5560
35	80-85	1	1	5400
36	75-80	1		
	80-85	1	2	5250
38	80-85	1		
	85-90	1		
	90-95	1		
	95-100	1	4	4970
39	75-80	2		
	100-105	1	3	4850
40	70-75	2		
	75-80	2		
	90-95	1	5	4730

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
41	95-100	1	1	4610
42	90-95	1	1	4500
43	70-75	2		
	95-100	1	3	4400
44	65-70	1		
	70-75	1		
	95-100	1	3	4300
45	65-70	1	1	4200
46	90-95	1	1	4110
47	65-70	1	1	4020
Median				5990
Average				5710

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 14, 250# Ex 17-0 Ring Bomb Ser. #5
Total Weight 243.38 Lbs.

3300 Frames per sec.
Comp. B
Filler Weight 91.49 Lbs.
Date: 19 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
27	175-180	1	7330
28	175-180	1	7070
31	175-180	1	6390
32	175-180	2	6190
33	175-180	1	6000
34	175-180	2	5820
35	175-180	1	5660
36	175-180	1	5500
37	175-180	1	5350
38	175-180	1	5210
39	170-175	1	5080
42	175-180	2	4710
45	175-180	1	4400
47	175-180	2	4210
48	175-180	2	4130
49	175-180	1	4040
50	170-175	1	3960
60	170-175	1	3300
65	170-175	1	3050
79	175-180	3 (Base Plug)	2510
80	175-180	1	2480
Median			4880
Average			4730

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 14, 250# Ex 17-0 Ring Bomb Ser. #5
Total Weight 243.38 Lbs.

3150 Frames per sec.
Comp. B
Filler Weight 91.49 Lbs.
Date: 19 March 1953

Frame in Which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
109	0-5	1	1730

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camere 1
Rd. 15. 250# Ex 17-0 Ring Bomb Ser. #6
Total Weight 245.54 Lbs.

3100 Frames per sec.
Comp. B
Filler Weight 92.46 Lbs.
Date: 20 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
29	95-100	4	4	6410
30	90-95	1		
	95-100	6	7	6200
31	90-95	3		
	95-100	7	10	6000
32	90-95	5		
	95-100	3		
	100-105	3	11	5810
33	85-90	2		
	90-95	2		
	100-105	2	6	5640
34	85-90	5		
	90-95	2		
	100-105	3	10	5470
35	85-90	1		
	95-100	1	2	5310
36	85-90	1		
	90-95	1		
	95-100	1	3	5170
37	80-85	2	2	5030
38	80-85	2		
	90-95	2		
	100-105	2	6	4890
39	90-95	1		
	105-110	2	3	4770
40	85-90	1		
	95-100	1	2	4650
41	95-100	2		
	100-105	1	3	4540

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
42	65-70	2		
	85-90	1	3	4430
43	90-95	1		
	95-100	1		
	100-105	1	3	4330
44	70-75	1		
	100-105	1	2	4230
45	85-90	1	1	4130
47	90-95	1	1	3960
Median				5610
Average				5410

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 15, 250# Ex 17-0 Ring Bomb Ser. #6
Total Weight 245.54 Lbs.

3150 Frames per sec.
Comp. B
Filler Weight 92.46 Lbs.
Date: 20 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
31	175-180	1	6100
32	175-180	1	5910
33	175-180	1	5730
35	175-180	2	5400
46	175-180	1	4110
54	165-170	1	3500
55	175-180	1	3440
60	175-180	1	3150
71	175-180	1	2660
72	175-180	1	2630
73	175-180	2 (Base Plug)	2590
74	175-180	1	2550
Median			3930
Average			3980

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE VIII

FRAGMENT VELOCITY DATA LOT 3

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 5, 250# Ex 17-0 Ring Bomb Ser. #7
Total Weight 244.86 lbs.

3050 Frames per sec.
Comp. B
Filler Weight 92.02 lbs.
Date: 9 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	90-95	1	1	6540
29	90-95	1		
	95-100	7	8	6310
30	90-95	2		
	95-100	5	7	6100
31	90-95	8		
	95-100	2		
	100-105	3	13	5900
32	85-90	3		
	90-95	4		
	95-100	1		
	100-105	2	10	5720
33	100-105	1	1	5550
34	85-90	3	3	5380
35	80-85	2		
	85-90	1		
	100-105	1	4	5230
36	80-85	1	1	5080
38	75-80	1		
	80-85	2		
	85-90	2		
	95-100	1	6	4820
39	75-80	1	1	4690
41	70-75	2	2	4460

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
42	75-80	1	1	4360
43	90-95	1	1	4260
44	65-70	2		
	95-100	1	3	4160
Median				5770
Average				5560

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 5, 250# Ex 17-0 Ring Bomb Ser. #7
Total Weight 244.86 lbs.

3000 Frames per sec.
Comp. B
Filler Weight 92.02 lbs.
Date: 9 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
24	175-180	1	1	7500
27	175-180	1	1	6670
32	135-140	1	1	5630
34	175-180	2	2	5290
35	175-180	2	2	5140
37	170-175	2	2	4860
41	175-180	2	2	4390
44	175-180	2	2	4090
50	175-180	1	1	3600
51	175-180 170-175	1 1	2	3530
67	175-180	1	1	2690
68	175-180	2 (Base Plug)	2	2650
71	175-180 160-165	1 1	2	2540
Median				4500
Average				4340

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 7, 250# Ex 17-0 Ring Bomb Ser. #8
Total Weight 247.90 lbs.

3000 Frames per sec.
Comp. B.
Filler Weight 91.80 lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
26	100-105	1	1	6920
28	95-100	5	5	6430
29	90-95	1		
	95-100	6	7	6210
30	90-95	3		
	95-100	4		
	100-105	4	11	6000
31	90-95	2		
	95-100	3		
	100-105	1	6	5810
32	85-90	2		
	90-95	1		
	95-100	2	5	5630
33	85-90	3		
	90-95	1		
	95-100	1		
	100-105	2	7	5450
34	80-85	1		
	85-90	3		
	100-105	1	5	5290
36	80-85	1		
	100-105	1	2	5000
37	80-85	1		
	90-95	1	2	4860
38	70-75	4		
	90-95	1	5	4740
42	85-90	2	2	4290

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
44	85-90	1	1	4090
45	95-100	1	1	4000
46	70-75	1	1	3910
50	85-90	1	1	3600
52	65-70	1		
	85-90	1	2	3460
Median				5750
Average				5480

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 7, 250# Ex 17-0 Ring Bomb Ser. #8
Total Weight 247.90 lbs.

3000 Frames per sec.
Comp. B
Filler Weight 91.80 lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
23	175-180	1	7830
26	175-180	1	6920
30	175-180	2	6000
31	175-180	1	5810
34	170-175	1	5290
35	175-180	1	5140
37	175-180	1	4860
38	170-175	1	4740
41	175-180	1	4390
44	175-180	1	4090
48	175-180	1	3750
49	175-108	1	3670
50	175-180	1	3600
52	160-165	1	3460
67	175-180	2 (Base Plug)	2690
68	175-180	1	2650
70	175-180	1	2570
Median			4500
Average			4530

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 3
Rd. 7, 250# Ex 17-0 Ring Bomb Ser. #8
Total Weight 247.90 lbs.

3050 Frames per sec.
Comp. B
Filler Weight 91.80 lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
107	0-5	2	1710
108	0-5	1	1690
Average			1700

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 9, 250# Ex 17-0 Ring Bomb Ser. #9
Total Weight 248.04 lbs.

3000 Frames per sec.
Comp. B
Filler Weight 91.18
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
27	95-100	1	1	6670
28	90-95	2	2	6430
29	95-100	6		
	90-95	5		
	95-100	4	15	6210
30	85-90	2		
	90-95	4		
	95-100	3		
	100-105	3	12	6000
31	90-95	1		
	100-105	5	6	5810
32	85-90	3	3	5630
33	85-90	1		
	100-105	4	5	5450
34	80-85	2		
	85-90	4	6	5290
35	80-85	1		
	100-105	2	3	5140
36	80-85	2		
	85-90	1		
	95-100	1	4	5000
37	75-80	1		
	90-95	2		
	95-100	1		
	75-80	2	6	4860
41	65-70	1	1	4390
42	95-100	1	1	4290
43	90-95	1	1	4190
Median				5850
Average				5650

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 9, 250# Ex 17-0 Ring Bomb Ser. #9
Total Weight 248.04 lbs.

3050 Frames per sec.
Comp. B
Filler Weight 91.18 lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
24	175-180	2	2	7630
25	175-180	1	1	7320
30	175-180	2	2	6100
32	175-180	4	4	5720
34	175-180	1	1	5380
37	175-180	1	1	4950
38	175-180	2	2	4820
40	165-170	1	1	4580
41	175-180	1	1	4460
43	175-180	1	1	4260
45	175-180	1	1	4070
48	175-180	1	1	3810
49	175-180	1	1	3730
59	160-165	1	1	3100
61	160-165 175-180	1 1	2	3000
65	170-175	1	1	2820
66	175-180	2 (Base Plug)	2	2770
69	175-180	1	1	2650
Median				4800
Average				4720

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE VIII (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 3
Rd. 9, 250# Ex 17-0 Ring Bomb Ser. #9
Total Weight 248.04 lbs.

3150 Frames per sec.
Comp. B
Filler Weight 91.18 lbs.
Date: 17 March 1953

Frame in Which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
108	0-5	1	1750

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE IX

FRAGMENT VELOCITY DATA LOT 4

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 6, 250# Ex 17-0 Ring Bomb Ser. #10
Total Weight 243.85 Lbs.

3050 Frames per sec.
Comp. B
Filler Weight 92.29 Lbs.
Date: 9 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
29	95-100	6	6	6310
30	95-100	7	7	6100
31	90-95	4		
	95-100	8	12	5900
32	90-95	1		
	95-100	2		
	100-105	2	5	5720
33	85-90	1		
	90-95	2		
	100-105	1	4	5550
34	85-90	1		
	90-95	1		
	100-105	1	3	5380
35	90-95	1		
	100-105	2	3	5230
36	85-90	1	1	5080
37	80-85	1		
	85-90	1		
	90-95	1		
	95-100	2	5	4950
38	80-85	1		
	90-95	1	2	4820
39	85-90	1		
	90-95	1	2	4690
40	80-85	1		
	85-90	1		
	95-100	1	3	4580

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
41	100-105	1	1	4460
43	65-70	1		
	70-75	1	2	4260
44	95-100	2	2	4160
Median				5700
Average				5480

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 6, 250# Ex 17-0 Ring Bomb Ser. #10
Total Weight 243.85 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 92.29 Lbs.
Date: 9 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
25	175-180	1	1	7200
27	175-180	1	1	6670
29	155-160	1	1	6210
31	170-175	2	2	5810
33	175-180	1	1	5450
43	165-170	1		
	175-180	1	2	4190
44	175-180	2	2	4090
46	175-180	1	1	3910
52	160-165	1	1	3460
66	175-180	1	1	2730
67	175-180	2 (Base Plug)	2	2690
68	175-180	2	2	2650
69	175-180	1	1	2610
72	175-180	1	1	2500
Median				4230
Average				4190

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 8, 250# Ex 17-0 Ring Bomb Ser. #11
Total Weight 246.62 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 91.26 Lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	95-100	3	3	6430
29	90-95	2		
	95-100	9	11	6210
30	90-95	4		
	95-100	4	8	6000
31	90-95	5		
	95-100	1		
	100-105	3	9	5810
32	85-90	5		
	90-95	3		
	95-100	2		
	100-105	3	13	5630
33	85-90	4		
	100-105	2	6	5450
34	85-90	1		
	100-105	2	3	5290
35	80-85	3		
	85-90	3	6	5140
36	80-85	1		
	85-90	1		
	95-100	1	3	5000
37	75-80	1		
	80-85	1	2	4860
38	75-80	2	2	4740
39	75-80	1		
	80-85	1		
	85-90	1	3	4620
40	100-105	1	1	4500

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
44	70-75	2		
	85-90	1		
	90-95	1	4	4090
47	65-70	1	1	3830
48	65-70	1		
	80-85	1	2	3750
Median				5660
Average				5460

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 8, 250# Ex 17-0 Ring Bomb Ser. #11
Total Weight 246.62 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 91.26 Lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
23	175-180	1	1	7830
31	175-180	1	1	5810
33	175-180	1	1	5450
34	175-180	2	2	5290
35	175-180	2	2	5140
38	175-180	1	1	4740
39	175-180	1	1	4620
40	175-180	1	1	4500
41	175-180	1	1	4390
42	170-175	1	1	4290
43	175-180	2	2	4190
44	175-180	1	1	4090
45	170-175	1	1	4000
46	170-175 175-180	1 1	2	3910
51	175-180 170-185	1 1	2	3530
55	165-170	1	1	3270
62	160-165	1	1	2900
64	165-170	1	1	2810
66	175-180	1	1	2730
67	175-180	3 (Base Plug)	3	2690
72	160-165	1	1	2500
Median				4160
Average				4150

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 3
Rd. 8, 250# Ex 17-0 Ring Bombs Ser. #11
Total Weight 246.62 Lbs.

3050 Frames per sec.
Comp. B
Filler Weight 91.26 Lbs.
Date: 10 March 1953

Frame in Which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
103	0-5	1	1780
108	0-5	1	1690
Average			1740

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 10, 250# Ex 17-0 Ring Bomb Ser. #12
Total Weight 244.80 Lbs.

2950 Frames per sec.
Comp. B
Filler Weight 91.48 Lbs.
Date: 11 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
25	100-105	1	1	7080
27	95-100	6	6	6560
28	90-95	5		
	95-100	9	14	6320
29	90-95	4		
	95-100	4		
	100-105	2	10	6100
30	90-95	2	2	5900
31	100-105	3	3	5710
32	85-90	2		
	100-105	2	4	5530
33	85-90	1		
	95-100	1		
	100-105	1	3	5360
34	80-85	3		
	85-90	3		
	90-95	1	7	5210
35	80-85	2		
	95-100	2		
	100-105	2	6	5060
36	75-80	1		
	80-85	1		
	85-90	1	3	4920
37	90-95	3		
	95-100	1		
	100-105	1	5	4780
38	75-80	3		
	90-95	2		
	95-100	1	6	4660

Fragmentation Test of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
39	70-75	1		
	75-80	1		
	95-100	1	3	4540
40	70-75	1		
	85-90	2		
	90-95	1	4	4430
41	65-70	1	1	4320
42	70-75	2		
	80-85	1	3	4210
43	65-70	1		
	95-100	1		
	100-105	1	3	4120
45	65-70	1	1	3930
Median				5470
Average				5420

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 10, 250# Ex 17-0 Ring Bomb Ser. #12
Total Weight 244.80 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 91.48 Lbs.
Date: 11 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
23	175-180	1	7830
24	175-180	1	7500
28	175-180	1	6430
30	175-180	1	6000
35	175-180	1	5140
38	175-180	1	4740
39	170-175	1	4620
42	175-180	1	4290
43	170-175	1	
	175-180	1	4190
46	170-175	1	3910
51	165-170	1	3530
57	165-170	1	3160
60	165-170	1	3000
65	160-165	1	2770
69	175-180	1 (Base Plug)	2610
70	175-180	1	2570
71	175-180	1	2540
Median			4200
Average			4390

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE IX (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 3
Rd. 10, 250# Ex 17-0 Ring Bomb Ser. #12
Total Weight 244.80 Lbs.

3050 Frames per sec.
Comp. B
Filler Weight 91.48 Lbs.
Date: 11 March 1953

Frame in Which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
90	10-15	1	2030
116	0-5	1	1580
Average			1810

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TABLE 1

FRAGMENT VELOCITY DATA LOT 5

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 1, 250# Ex 17-0 Ring Bomb Ser #13
Total Weight 247.70 Lbs.

2550 Frames per sec.
Comp. B
Filler Weight 91.30 Lbs.
Date: 5 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
24	95-100	3	3	6380
25	90-95	2		
	95-100	11	13	6120
26	90-95	5		
	95-100	3		
	100-105	5	13	5880
27	90-95	2		
	100-105	1	3	5670
28	90-95	2		
	95-100	1		
	100-105	1		
	85-90	7	11	5460
29	85-90	4		
	100-105	3	7	5280
30	90-95	2		
	100-105	1		
	85-90	3		
	80-85	2	8	5100
31	100-105	1		
	85-90	1		
	80-85	4	6	4940
32	105-110	1		
	80-85	1	2	4780
33	85-90	1		
	80-85	1	2	4640
34	75-80	4	4	4500

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
36	75-80	1		
	70-75	1		
	100-105	1	3	4250
38	65-70	2	2	4030
Median				5570
Average				5420

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 1, 250# Ex 17-0 Ring Bomb Ser #13
Total weight 247.70 Lbs.

2550 Frames per sec.
Comp. B
Filler Weight 91.30 Lbs.
Date: 5 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
23	175-180	2	2	6650
26	175-180	2	2	5880
30	175-180	2	2	5100
31	175-180	1	1	4940
34	175-180	1	1	4500
35	175-180	1	1	4370
37	175-180	2	2	4140
39	175-180	1	1	3920
40	175-180	1	1	3830
43	175-180	1	1	3560
44	175-180	2	2	3480
45	175-180	1	1	3400
50	175-180	1	1	3060
51	175-180 160-165	1 1	2	3000
54	175-180	1	1	2830
57	160-165 175-180	1 (Base 3 Plug)	4	2680
59	175-180	1	1	2590
Median				3830
Average				4010

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 2, 250# Ex 17-0 Ring Bomb Ser #14
Total Weight 247.28 Lbs.

2550 Frames per sec.
Comp. B
Filler Weight 91.28 Lbs.
Date: 5 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
24	95-100	2	2	6380
25	90-95	2		
	95-100	8	10	6120
26	90-95	5		
	95-100	1		
	100-105	1	7	5880
27	85-90	1		
	90-95	2		
	95-100	4		
	100-105	1	8	5670
28	85-90	2		
	90-95	2		
	100-105	2	6	5460
29	80-85	1		
	85-90	1		
	95-100	1		
	100-105	1	4	5280
30	80-85	3		
	85-90	2		
	100-105	1	6	5100
31	80-85	3		
	85-90	1		
	100-105	4	8	4940
32	80-85	6	6	4780
33	80-85	1		
	75-80	1		
	105-110	1	3	4640
35	75-80	1	1	4370
36	70-75	1	1	4250
Median				5500
Average				5410

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 2, 250# Ex 17-0 Ring Bomb Ser #14
Total Weight 247.28 Lbs.

2550 Frames per sec.
Comp. B
Filler Weight 91.28 Lbs.
Date: 5 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Total Hits	Velocity (f/s)
22	175-180	2	2	6950
23	175-180	1	1	6650
28	175-180	1	1	5460
31	175-180	1	1	4940
35	170-175	1	1	4370
39	175-180 165-170	2 1	3	3920
40	175-180	2	2	3830
49	165-170	1	1	3120
51	175-180	1	1	3000
55	160-165	1	1	2780
56	160-165	1	1	2730
60	175-180	3 (Base Plug)	3	2550
Median				3920
Average				4110

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17-0 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 3, 250# Ex 17-0 Ring Bomb Ser #15
Total Weight 250.08 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 93.12 Lbs.
Date: 6 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	95-100	3	3	6430
29	95-100	5		
	90-95	2	7	6210
30	90-95	7		
	95-100	4	11	6000
31	85-90	3		
	90-95	4		
	95-100	1	8	5810
32	85-90	3		
	90-95	1	4	5630
33	85-90	7		
	90-95	3		
	95-100	2		
	100-105	1	13	5450
34	85-90	2		
	95-100	2	4	5290
35	80-85	1		
	95-100	2		
	100-105	1	4	5140
36	80-85	1		
	75-80	2		
	100-105	1	4	5000
37	80-85	1	1	4860
38	75-80	1	1	4740
39	100-105	1		
	75-80	1	2	4620
40	90-95	1	1	4500

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17-0 Mod C

TABLE X (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
41	65-70	2	2	4390
42	75-80	1	1	4290
44	65-70	2	2	4090
Median				5700
Average				5510

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 3, 250# Ex 17-0 Ring Bomb Ser #15
Total Weight 250.08 Lbs.

3150 Frames per sec.
Comp. B
Filler Weight 93.12 Lbs.
Date: 6 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
23	175-180	1	8220
26	175-180	1	7270
28	175-180	1	6750
29	175-180	2	6520
30	175-180	1	6300
32	175-180	2	5910
39	175-180	1	4850
40	175-180	3	4730
41	175-180	1	4610
42	175-180	2	4500
43	175-180	1	4400
48	165-170	1	3940
50	170-175	1	3780
52	165-170	2	3630
59	165-170	1	3200
63	175-180	1	3000
64	165-170	1	2950
65	175-180	2 (Base Plug)	2910
66	175-180	2	2860
Median			4650
Average			4670

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 4, 250# Ex 17-0 Ring Bomb Ser #16
Total Weight 248.52 Lbs.

2950 Frames per sec.
Comp. B
Filler Weight 92.24 Lbs.
Date: 7 March 1953

Frame in which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
27	95-100	1	1	6560
28	95-100	3	3	6320
29	90-95	1		
	95-100	7		
	100-105	1	9	6100
30	90-95	3		
	95-100	2		
	100-105	1	6	5900
31	90-95	4		
	95-100	2		
	100-105	3	9	5710
32	90-95	5	5	5530
33	85-90	3	3	5360
34	80-85	2	2	5210
35	80-85	2	2	5060
36	95-100	2		
	100-105	2		
	80-85	2	6	4920
37	80-85	2		
	85-90	1	3	4780
38	85-90	1	1	4660
39	85-90	1		
	95-100	1	2	4540
40	95-100	1		
	105-110	1		
	75-80	1	3	4430

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE X (Continued)

Frame in which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
41	95-100	1		
	100-105	1	2	4320
42	65-70	1	1	4210
43	90-95	2		
	65-70	1	3	4120
44	85-90	1	1	4020
Median				5550
Average				5350

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 4, 250# Ex 17-0 Ring Bomb Ser #16
Total Weight 248.52 Lbs.

3000 Frames per sec.
Comp. B
Filler Weight 92.24 Lbs.
Date: 7 March 1953

Frame in Which Hit Occurred	Zone	Base No. Fragments		Total Hits	Velocity (f/s)
24	175-180	1		1	7500
27	175-180	1		1	6670
29	175-180	2		2	6210
31	175-180	2		2	5810
42	170-175	1		1	4290
44	175-180	1		1	4090
45	175-180	1		1	4000
47	175-180	1		1	3830
48	175-180	1		1	3750
50	175-180	1		1	3600
55	175-180	1			
	155-160	1		2	3270
57	175-180	1		1	3160
65	170-175	1		1	2770
69	175-180	2	(Base Plug)	2	2610
70	175-180	1		1	2570
72	175-180	1		1	2500
Median					3860
Average					4230

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 16, 250# Ex 17-0 Ring Bomb Ser #17
Total Weight 248.33 Lbs.

3100 Frames per sec.
Comp. B
Filler Weight 92.22 Lbs.
Date: 20 March 1953

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
28	95-100	2		
	100-105	1	3	6640
29	90-95	1		
	95-100	3	4	6410
30	90-95	2		
	95-100	5		
	100-105	4	11	6200
31	85-90	1		
	95-100	4		
	100-105	2	7	6000
32	85-90	3		
	90-95	6		
	95-100	1	10	5810
33	85-90	2		
	90-95	2	4	5640
34	100-105	1	1	5470
35	80-85	2		
	85-90	1	3	5310
36	80-85	2		
	85-90	2		
	100-105	1	5	5170
37	80-85	3		
	95-100	1	4	5030
38	75-80	1	1	4890
39	75-80	2		
	80-85	1	3	4770
40	75-80	1	1	4650

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

Frame in Which Hit Occurred	Zone	Beam No. Fragments	Total Hits	Velocity (f/s)
42	70-75	1		
	85-90	1		
	95-100	1	3	4430
43	85-90	1	1	4330
44	65-70	1	1	4230
45	65-70	1	1	4130
48	85-90	1	1	3880
51	65-70	1	1	3650
Median				5800
Average				5560

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd. 16, 250# Ex 17-0 Ring Bomb Ser #17
Total Weight 248.33 Lbs.

3200 Frames per sec.
Comp. B
Filler Weight 92.22 Lbs.
Date: 20 March 1953

Frame in which Hit Occurred	Zone	Base No. Fragments	Velocity (f/s)
24	175-180	1	8000
26	175-180	1	7380
30	175-180	1	6400
32	175-180	1	6000
33	175-180	3	5820
34	175-180	1	5650
36	175-180	2	5330
39	175-180	2	4920
40	175-180	1	4800
42	175-180	1	4570
44	175-180	1	4360
45	175-180	1	4270
46	165-170	1	4170
69	175-180	2 (Base Plug)	2780
70	175-180	1	2740
71	175-180	1	2700
Median			5200
Average			4980

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 16, 250# Ex 17-0 Ring Bomb Ser #17
Total Weight 248.33 Lbs.
3100 Frames per sec.
Comp. B
Filler Weight 92.22 Lbs.
Date: 20 March 1953

Frame in which Hit Occurred	Zone	Nose No. Fragments	Velocity (f/s)
112	0-5	1	1660

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

- -

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 1
Rd. 17, 250# Ex 17-0 Ring Bomb Ser #18
Total Weight 248.09 Lbs.

2950 Frames per sec.
Comp. B
Filler Weight 91.20 Lbs.
Date: 23 March 1953 (water Pit)

Frame in which Hit Occurred	Zone	Beam Spray (84° - 107°) No. Fragments	Total Hits	Velocity (f/s)
28	95-101	1	1	6320
29	95-101	10		
	101-107	5	15	6100
30	90-95	4		
	95-101	10		
	101-107	8	22	5900
31	90-95	6		
	95-101	5		
	101-107	4	15	5710
32	90-95	11		
	95-101	2		
	101-107	11	24	5530
33	84-90	3		
	90-95	7		
	95-101	2		
	101-107	4	16	5360
34	84-90	8		
	90-95	6		
	101-107	5	19	5210
35	84-90	3		
	90-95	2		
	95-101	1		
	101-107	5	11	5060
36	84-90	4		
	101-107	3	7	4920
37	84-90	2		
	95-101	2		
	101-107	3	7	4780
38	95-101	1	1	4660

Fragmentation Tests of Notched-Ring Bombs, 250 lb., Type Ex 17 Mod 0

TABLE X (Continued)

Frame in Which Hit Occurred	Zone	Beam Spray (84° - 107°) No. Fragments	Total Hits	Velocity (f/s)
39	90-95	2		
	95-101	1	3	4540
40	84-90	1		
	90-95	1	2	4430
41	84-90	1		
	90-95	1		
	95-101	2		
	101-107	1	5	4320
42	84-90	2	2	4210
44	84-90	1		
	101-107	2	3	4020
Median				5530
Average				5380

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

60 Ft. Radius Arena
35mm Fastax Camera 2
Rd 17, 250# Ex 17-0 Ring Bomb Ser #18
Total Weight 248.09 Lbs.

2950 Frames per sec.
Comp. B
Filler Weight 91.20 Lbs.
Date: 23 March 1953
(Water Pit)

Frame in which Hit Occurred	Zone	Beam Spray (84° - 107°) No. Fragments	Total Hits	Velocity (f/s)
29	95-101	3	3	6100
30	95-101	11		
	101-107	9	20	5900
31	90-95	8		
	95-101	6		
	101-107	9	23	5710
32	90-95	8		
	95-101	5		
	101-107	7	20	5530
33	90-95	9		
	95-101	3		
	101-107	8	20	5360
34	84-90	2		
	90-95	10		
	95-101	2		
	101-107	6	20	5210
35	84-90	10		
	90-95	4		
	101-107	5	19	5060
36	84-90	5		
	90-95	2		
	101-107	4	11	4920
37	84-90	3		
	101-107	2	5	4780
38	84-90	2		
	95-101	2		
	101-107	3	7	4660
39	95-101	1	1	4540

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

TABLE X (Continued)

Frame in which Hit Occurred	Zone	Beam Spray (84° - 107°) No. Fragments	Total Hits	Velocity (f/s)
40	90-95	1	1	4430
42	84-90	1		
	95-101	1		
	101-107	1	3	4210
45	84-90	1		
	101-107	1	2	3930
47	84-90	1		
	101-107	1	2	3770
Median				5440
Average				5310

TABLE XI

MASS DISTRIBUTION DATA

250 lb Bomb Type EX 17-0, Comp B loaded
Sample Fragments Recovered in cane fiberboard pack, zone 90°-106°, 4' high at 60' distance

NUMBER AND WEIGHT OF RECOVERED FRAGMENTS

Bomb Ser No.	0-0.625 grams Wt. Gms.	0.625-1.25 grams Wt. Gms.	No.	1.25-2.5 grams Wt. Gms.	No.	2.5-3.5 grams Wt. Gms.	No.	3.5-4.5 grams Wt. Gms.	No.	4.5-5.5 grams Wt. Gms.	No.	5.5-6.5 grams Wt. Gms.	No.	6.5-7.5 grams Wt. Gms.	No.	7.5-8.5 grams Wt. Gms.	No.	8.5-9.5 grams Wt. Gms.	No.	9.5-10.5 grams Wt. Gms.	No.	10.5-21.5 grams Wt. Gms.	No.	Total 5/8-21 grams No.	Gms.	Photo. No. NP9
1	7.4	17.5	21	82.2	42	68.4	25	149.2	37	25.7	5	107.1	17	48.0	7	8.3	1	--	--	--	--	12.0	1	156	518.4	63084
2	5.9	30.1	34	49.1	25	44.4	16	110.9	28	14.2	3	81.3	13	138.0	21	--	--	--	--	--	--	--	--	140	468.0	63084
Avg. Lot #1	8.7	23.8	28	85.7	34	56.4	21	130.1	33	20.0	4	94.2	15	93.0	14	4.2	.5	--	--	--	--	8.0	.5	148	493.2	--
4	6.1	20.8	27	54.6	28	72.8	25	112.9	29	25.4	5	66.9	11	106.5	16	--	--	--	--	--	--	--	--	141	459.9	63181
5	8.2	20.5	25	25.3	15	40.3	14	46.6	12	9.6	2	48.8	8	228.7	34	--	--	--	--	10.0	1	--	--	111	427.7	63181
6	4.0	20.7	26	34.1	19	25.9	9	44.7	11	9.1	2	53.9	9	139.4	21	15.3	2	--	--	19.7	2	16.8	1	102	379.4	63181
Avg. Lot #2	8.1	20.7	26	38.0	21	48.3	16	68.1	17	14.7	3	56.5	9	157.5	24	5.1	.7	--	--	9.9	1	5.5	.3	118	422.3	--
7	6.1	9.4	11	55.4	27	48.8	16	62.3	15	29.8	6	98.4	16	93.2	14	--	--	--	--	--	--	21.0	1	106	418.1	63015
8	13.8	17.2	19	73.7	35	59.9	21	109.9	27	45.8	9	144.0	24	155.0	23	--	--	--	--	10.1	1	--	-	159	813.8	63015
9	11.5	6.7	9	48.4	24	33.8	12	63.8	16	24.6	5	115.0	19	200.3	30	--	--	--	--	--	--	--	-	115	492.8	63015
Avg. Lot #3	10.5	11.1	13	59.2	29	47.4	16	78.7	19	32.7	7	119.1	20	149.5	22	--	--	--	--	3.4	.3	7.0	.3	127	508.1	--
10	9.8	15.0	18	33.5	18	25.3	9	63.7	16	103.0	21	89.9	15	55.5	8	7.7	1	--	--	--	--	13.0	1	106	406.6	62813
11	13.5	23.4	25	62.4	33	30.3	10	85.2	21	78.2	18	120.3	20	98.3	14	18.9	2	--	--	--	--	--	-	141	506.9	62813
12	12.5	17.1	20	26.3	15	29.8	10	59.8	15	50.7	10	108.5	18	41.8	6	41.4	5	--	--	9.8	1	11.7	1	101	398.7	62813
Avg. Lot #4	11.9	18.5	21	41.4	22	28.5	10	69.6	17	77.3	16	106.2	18	85.1	9	21.7	3.7	--	--	3.3	.7	2	.7	118	438.1	--

TABLE XI (Continued)

250 lb. Bomb Type EX 17-0, Comp B loaded
Sample Fragments Recovered in cane fiberboard pack, zone 90°-106°, 4' high at 60' distance

NUMBER AND WEIGHT OF RECOVERED FRAGMENTS

Bomb Ser. No.	0-0.625 grams Wt. Gms.	0.625-1.25 grams Wt. Gms.	No.	1.25-2.5 grams Wt. Gms.	No.	2.5-3.5 grams Wt. Gms.	No.	3.5-4.5 grams Wt. Gms.	No.	4.5-5.5 grams Wt. Gms.	No.	5.5-6.5 grams Wt. Gms.	No.	6.5-7.5 grams Wt. Gms.	No.	7.5-8.5 grams Wt. Gms.	No.	8.5-9.5 grams Wt. Gms.	No.	9.5-10.5 grams Wt. Gms.	No.	10.5-21.5 grams Wt. Gms.	No.	Total 5/8-21 grams No.	Gms.	Photo No. NP9
13	5.7	17.3	21	31.3	17	29.3	10	27.7	7	34.9	7	84.0	14	55.1	8	46.4	6	36.1	4	49.0	5	11.0	1	100	422.1	62648
14	7.3	17.7	20	19.0	10	20.7	7	24.3	6	73.2	15	34.5	6	28.6	4	31.7	4	35.9	4	38.8	4	32.6	3	83	355.0	62648
15	7.7	15.5	18	33.5	18	32.6	11	49.3	13	73.4	15	53.2	9	76.9	11	23.6	3	36.2	4	9.6	1	62.8	5	108	466.6	62985
16	6.9	14.0	16	28.3	15	8.2	3	25.2	6	14.8	3	60.7	10	42.2	6	23.6	3	18.1	2	50.0	5	63.2	5	74	348.3	62985
17	3.9	22.5	25	16.5	9	33.0	11	86.3	22	57.6	12	40.7	10	139.4	21	40.2	5	9.4	1	20.1	2	66.1	6	124	551.3	62985
Avg. Lot #6	6.3	17.4	20	25.7	14	24.9	8	42.4	11	50.8	10	58.6	10	68.0	10	33.1	4.2	27.1	3	33.5	3.4	47.1	4	98	428.7	---
	Fragments Recovered from NPG Water Pit which represent 1/6 of total expected in zone 60°-120° Bomb No. 18, Lot 5.																									
18	914	330	407	417	231	558	187	874	222	1047	209	1026	173	742	107	761	97	490	55	376	38	458	40	1766	7079	63021

FRAG NO. 1725 [redacted]

250 LB BOMBS EX 17 MOD 0
SAMPLE BEAM SPRAY FRAGMENTS

NP9 NO. 63084

SERIAL NO 1

		90-94°	94-98°	98-102°	102-106°
0 - 5/8	GMS.				
	PCS.	8	8	9	6
	GMS.	1.7	1.6	2.7	1.4
5/8 - 1¼	GMS.				
	PCS.	3	3	9	6
	GMS.	2.2	2.5	8.1	4.7
1¼ - 2½	GMS.				
	PCS.	8	9	16	9
	GMS.	13.9	18.0	32.1	18.2
2½ - 3½	GMS.				
	PCS.	3	4	9	9
	GMS.	8.0	11.1	24.9	24.4
3½ - 4½	GMS.				
	PCS.	7	8	12	10
	GMS.	28.0	31.2	49.0	41.0
4½ - 5½	GMS.				
	PCS.	1	2	1	1
	GMS.	5.2	10.3	5.0	5.2
5½ - 6½	GMS.				
	PCS.	3	4	5	5
	GMS.	19.2	25.0	31.6	31.3
6½ - 7½	GMS.				
	PCS.	1	3		3
	GMS.	6.5	19.5		20.0
7½ - 8½	GMS.				
	PCS.		1		
	GMS.		7.3		
8½ - 9½	GMS.				
	PCS.				
	GMS.				
9½ - 10½	GMS.				
	PCS.				
	GMS.				
10½ - 11½	GMS.				
	PCS.				
	GMS.				
11½ - 12½	GMS.				
	PCS.		1		
	GMS.		12.0		
12½ - 13½	GMS.				
	PCS.				
	GMS.				
13½ - 14½	GMS.				
	PCS.				
	GMS.				

SERIAL NO 2

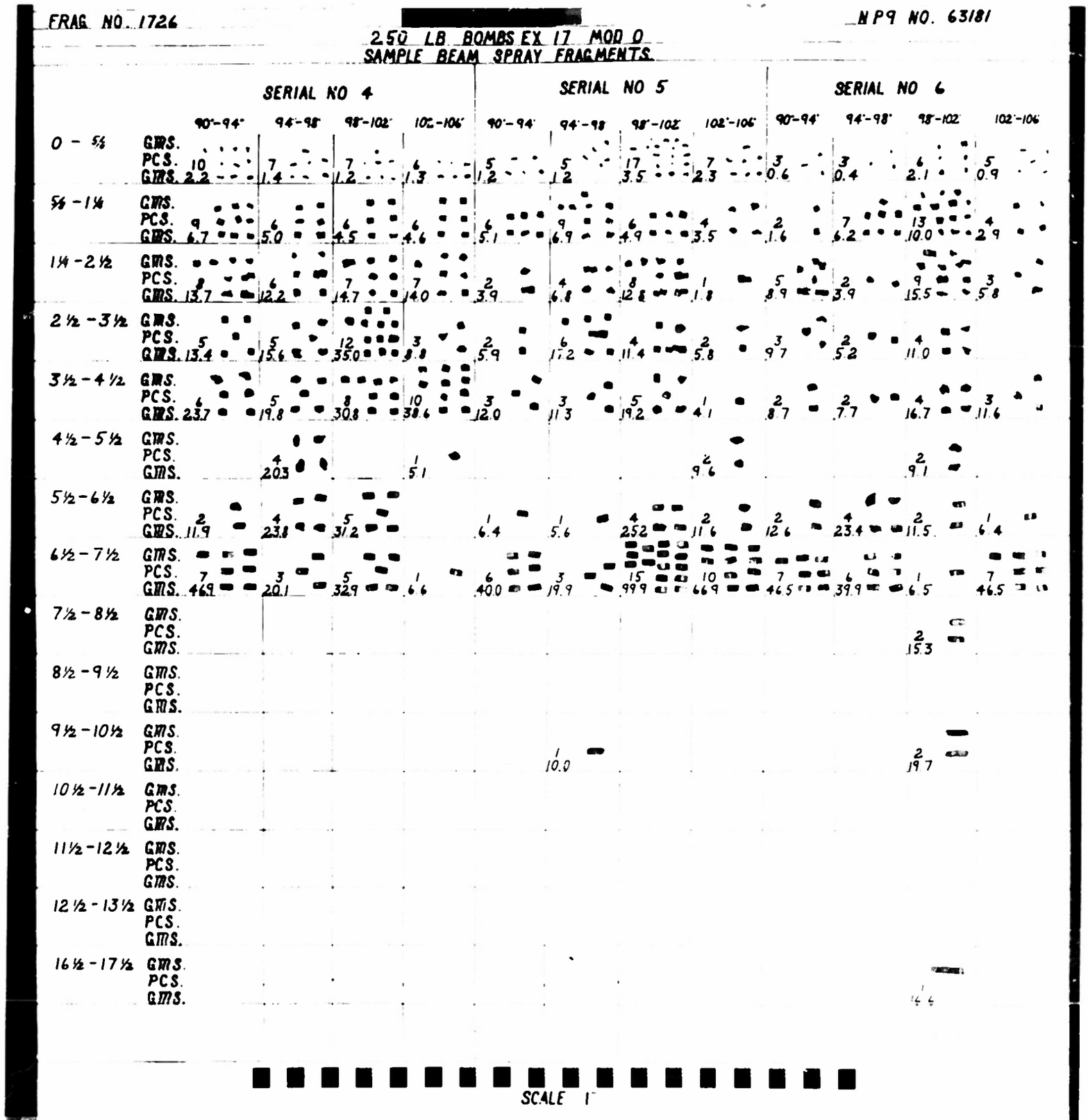
90-94	94-98	98-102	102-106
4	7	9	4
0.9	1.5	2.4	1.1
4	12	10	8
5.5	10.7	9.2	6.7
6	7	5	7
10.6	13.5	10.4	14.6
2	3	6	5
5.8	8.4	16.3	13.9
6	3	11	8
23.2	12.7	43.3	31.7
1		1	1
5.0		4.7	4.5
5	3	3	2
31.5	18.1	19.2	12.5
3	3	9	6
19.8	20.0	58.6	39.6

SCALE 1

NP9-63084 18 March 1953 CONFIDENTIAL SECURITY INFORMATION
250 lb. Bomb Type EX 17 Mod 0 Lot 1. Fragments recovered in 4' high cane fiberboard pack at 60'.
Figure 9

FRAG NO. 1726 [redacted] NPG NO. 63181

250 LB BOMBS EX 17 MOD 0
SAMPLE BEAM SPRAY FRAGMENTS

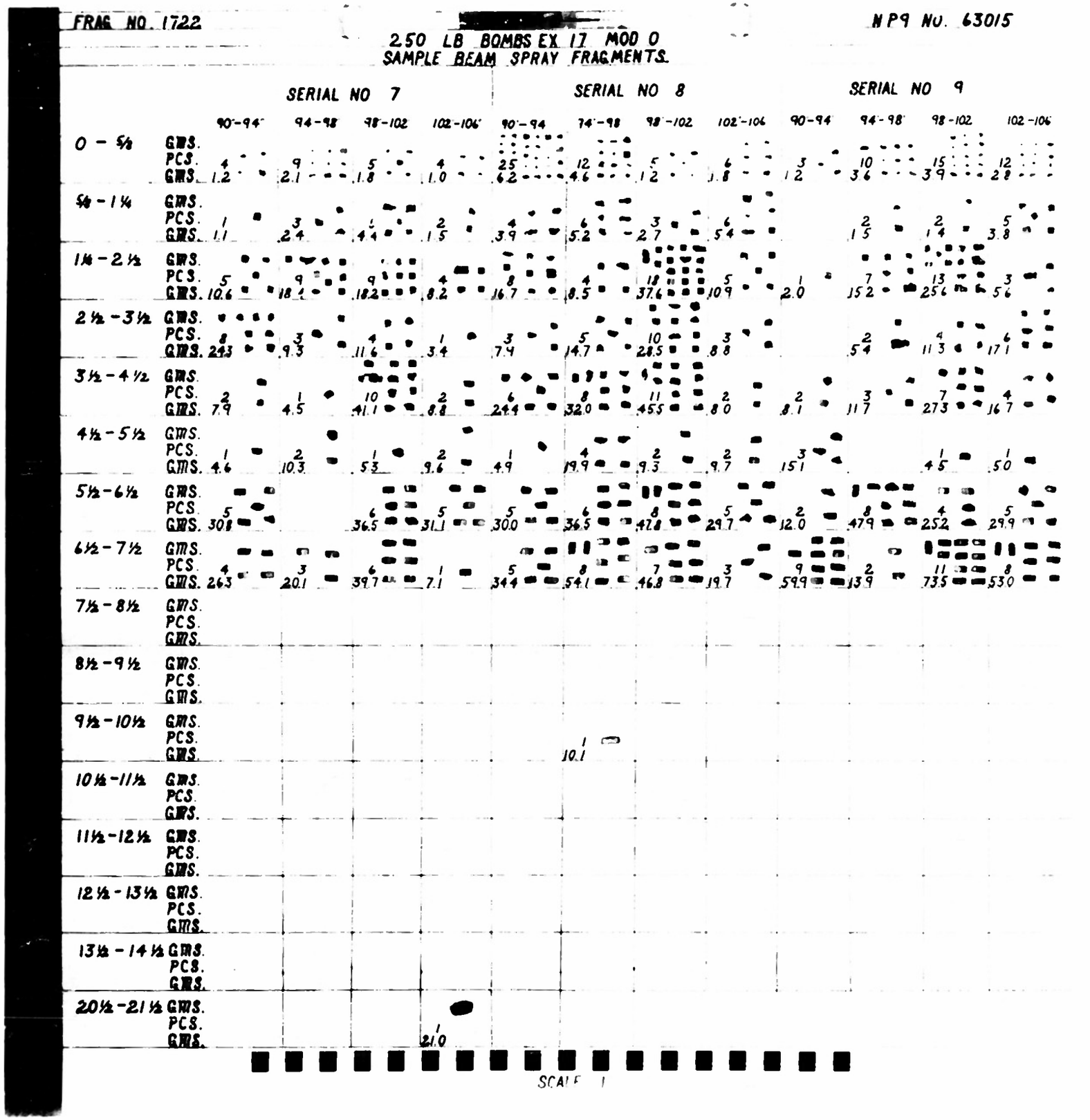


[redacted]

FRAG NO. 1722

NPG NO. 63015

250 LB BOMBS EX 17 MOD 0
SAMPLE BEAM SPRAY FRAGMENTS



[redacted]

FRAG NO. 1721 [redacted] NPG NO. 62813

2.50 LB BOMB EX 17 MOD 0
SAMPLE BEAM SPRAY FRAGMENTS.

		SERIAL NO 10				SERIAL NO 11				SERIAL NO 12			
		90°-94°	94-98°	98°-102°	102°-106°	90°-94°	74°-98°	98°-102°	102°-106°	90-94°	94-98°	98-102°	102-106°
0 - 5½	GMS.												
	PCS.	7	11	10	3	10	12	9	8	14	10	5	10
	GMS.	1.7	3.5	3.2	1.2	.3	4.6	2.9	2.3	4.4	2.8	1.7	3.6
5½ - 1¼	GMS.												
	PCS.	4	11	3		4	11	8	2	8	6	3	3
	GMS.	2.9	9.5	2.6		3.4	10.4	8.1	1.5	6.9	4.6	2.4	3
1¼ - 2½	GMS.												
	PCS.	5	1	4	8	10	10	10	3	2	7	4	2
	GMS.	10.3	1.5	7.2	14.5	19.9	17.4	18.6	6.5	4.5	13.4	7.3	3.1
2½ - 3½	GMS.												
	PCS.	1	3	3	2	3	3	4		1	4	5	
	GMS.	2.9	7.9	8.8	5.7	9.2	9.4	11.7		3.2	11.9	14.7	
3½ - 4½	GMS.												
	PCS.	2	3	7	4	4	5	8	4	4	6	4	1
	GMS.	8.2	12.1	27.5	15.9	16.5	19.9	32.8	16.	16.5	23.7	15.9	3.7
4½ - 5½	GMS.												
	PCS.	5	9	5	2	3	3	8	2	4	5	1	
	GMS.	24.2	44.9	23.9	10.	14.1	14.8	38.8	10.5	20.3	25.	5.4	
5½ - 6½	GMS.												
	PCS.	3	2	7	3	5	4	6	5	1	7	4	6
	GMS.	12.6	12.6	41.3	18.4	29.8	24.3	35.5	30.7	5.5	42.5	23.7	36.8
6½ - 7½	GMS.												
	PCS.	1		5	2	1	5	5	3	1	1	3	
	GMS.	7.4		33.9	14.2	6.6	33.3	34.1	19.8	7.2	6.6	20.	
7½ - 8½	GMS.												
	PCS.		1			1		1			2	2	1
	GMS.		7.7			7.9		8.1			15.9	14.2	7.8
8½ - 9½	GMS.												
	PCS.												1
	GMS.												9.3
9½ - 10½	GMS.												
	PCS.										1		
	GMS.										9.8		
10½ - 11½	GMS.												
	PCS.												
	GMS.												
11½ - 12½	GMS.												
	PCS.												
	GMS.											1	
												11.7	
12½ - 13½	GMS.												
	PCS.		1										
	GMS.		13.										

SCALE 1"

[redacted] 11 March 1953 [redacted]
[redacted] 2.50 lb. [redacted] type EX 17 Mod 0 Lot 4. Fragments recovered [redacted] ca[redacted] fi[redacted] board [redacted] at 60'.

Figure 12

FRAG NO. 11718 [redacted] NPG NO. 62648

2.50 LB BOMB EX 17 MOD 0
SAMPLE BEAM SPRAY FRAGMENTS

		SERIAL NO 13				SERIAL NO 14			
		90°-94°	94°-98°	98°-102°	102°-106°	90°-94°	94°-98°	98°-102°	102°-106°
0 - ½	GWS.								
	PCS.	2	3	4	5	4	4	4	8
	GWS.	.9	.9	1.9	2.	1.5	1.3	1.7	2.8
½ - 1½	GWS.								
	PCS.	5	3	6	7	3	3	7	7
	GWS.	4.4	2.6	4.9	5.4	3.	3.1	5.5	6.1
1½ - 2½	GWS.								
	PCS.	3	6	5	3	3	4	2	1
	GWS.	5.2	10.5	9.1	6.5	5.1	7.8	4.1	2.
2½ - 3½	GWS.								
	PCS.	5	1	4		2	1	3	1
	GWS.	13.8	3.3	12.2		6.1	2.9	8.7	3.
3½ - 4½	GWS.								
	PCS.	2	3	1	1	2	2	2	
	GWS.	8.1	11.7	4.1	3.9	8.3	7.7	8.3	
4½ - 5½	GWS.								
	PCS.	1	4		2	3	3	5	4
	GWS.	4.9	20.2		9.8	14.6	15.3	24.3	19.
5½ - 6½	GWS.								
	PCS.	4	2	5	3	2	2	1	1
	GWS.	23.	12.7	30.2	18.1	11.3	11.5	5.7	6.
6½ - 7½	GWS.								
	PCS.	3		2	3		2	1	1
	GWS.	20.5		13.7	20.9		13.3	6.6	1.7
7½ - 8½	GWS.								
	PCS.		2	3	1		1	3	
	GWS.		15.8	22.9	7.7		8.2	23.5	
8½ - 9½	GWS.								
	PCS.		2	1	1		1	1	2
	GWS.		18.	9.2	8.9		9.4	8.8	17.7
9½ - 10½	GWS.								
	PCS.	1	2	1	1	1	1	1	1
	GWS.	9.7	20.	9.8	9.5	9.9	9.6	9.5	9.8
10½ - 11½	GWS.								
	PCS.		1					3	
	GWS.		11.					32.6	
11½ - 12½	GWS.								
	PCS.								
	GWS.								
NOSE - FRAGMENT. 0° 448.4	GWS.								

SCALE 1"

FRAG NO. 1720 [redacted] MPG NO. 62985

2.50 LB BOMB EX 17 MOD 0

SAMPLE BEAM SPRAY FRAGMENTS

		SERIAL NO 15				SERIAL NO 16				SERIAL NO 17			
		90°-94°	94°-98°	98°-102°	102°-106°	90°-94°	94°-98°	98°-102°	102°-106°	90°-94°	94°-98°	98°-102°	102°-106°
0 - ½	GWS.												
	PCS.	7	3	6	7	2	4	10	6	3	5	3	2
	GWS.	2.1	1.3	2.1	2.2	.6	1.2	3.6	1.5	.8	1.5	1.0	.6
½ - 1½	GWS.												
	PCS.	2	4	9	3	4	5	5	2	7	8	10	
	GWS.	1.8	4.1	7.1	2.5	4.4	4.1	4.0	1.5	6.0	7.0	9.5	
1½ - 2½	GWS.												
	PCS.	6	1	10	1	3	4	6	2	1	2	4	2
	GWS.	11.4	1.9	18.1	2.1	5.1	7.3	12.8	3.1	1.5	3.4	8.0	3.6
2½ - 3½	GWS.												
	PCS.	2	1	3	5		1	1	1	3	4	3	1
	GWS.	6.1	2.6	8.8	15.1		3.2	2.5	2.5	8.5	11.9	9.9	3.2
3½ - 4½	GWS.												
	PCS.	3	3	4	3	3	2	1		3	7	6	6
	GWS.	10.8	11.6	15.5	11.4	12.3	8.7	4.2		11.1	27.8	22.6	23.8
4½ - 5½	GWS.												
	PCS.	3	1	9	2	1	2			4	3	2	3
	GWS.	14.7	5.0	44.2	9.5	4.7	10.1			19.5	14.2	9.3	14.6
5½ - 6½	GWS.												
	PCS.	4		3	2	3	2	3	2	3	4	1	2
	GWS.	24.0		17.3	11.9	18.4	12.5	17.9	11.9	18.8	24.4	6.3	11.2
6½ - 7½	GWS.												
	PCS.	2		6	3	1	1	3	1	3	7	10	1
	GWS.	13.3		42.4	21.0	6.7	7.3	21.1	7.1	20.3	45.8	46.7	6.6
7½ - 8½	GWS.												
	PCS.			2	1	1	1	1		2	1		2
	GWS.			15.9	7.7	7.5	8.0	8.1		15.5	8.1		16.6
8½ - 9½	GWS.												
	PCS.												
	GWS.		1	1	2	2				1			
			9.4	9.0	17.8	18.1				9.4			
9½ - 10½	GWS.												
	PCS.						1	3	1		2		
	GWS.		1				9.9	30.5	9.6		20.1		
			9.6										
10½ - 11½	GWS.												
	PCS.												
	GWS.		1	1	1		2				3		2
			10.8	11.1	11.1		21.3				31.5		22.2
11½ - 12½	GWS.												
	PCS.												
	GWS.									1			
										12.4			
12½ - 13½	GWS.												
	PCS.							1					
	GWS.							12.9					
13½ - 14½	GWS.												
	PCS.						1						
	GWS.						14.0						
14½ - 15½	GWS.												
	PCS.		1	1			1						
	GWS.		14.6	15.2			15.0						

[redacted] Lot 5. [redacted]

[redacted] re 14

FRAG NO. 1728

N.P.9 NO 63021

250 LB BOMB EX 17 MOD 0 SERIAL NO 18 WATER PIT

ZONE 60°-120°

0 - 5/8	GMS.	
	PCS.	
914	GMS.	
5/8 - 1¼	GMS.	
407	PCS.	
330	GMS.	
1¼ - 2½	GMS.	
231	PCS.	
417	GMS.	
2½ - 3½	GMS.	
187	PCS.	
558	GMS.	
3½ - 4½	GMS.	
222	PCS.	
874	GMS.	
4½ - 5½	GMS.	
209	PCS.	
1047	GMS.	
5½ - 6½	GMS.	
173	PCS.	
1026	GMS.	
6½ - 7½	GMS.	
107	PCS.	
742	GMS.	
7½ - 8½	GMS.	
97	PCS.	
761	GMS.	
8½ - 9½	GMS.	
55	PCS.	
490	GMS.	
9½ - 10½	GMS.	
38	PCS.	
376	GMS.	
10½ - 11½	GMS.	
26	PCS.	
283	GMS.	
11½ - 12½	GMS.	
9	PCS.	
107	GMS.	
12½ - 13½	GMS.	
2	PCS.	
26	GMS.	
13½ - 14½	GMS.	
3	PCS.	
42	GMS.	

SCALE 1"

NPG-63021 23 March 1953 CONFIDENTIAL SECURITY INFORMATION

250 lb. Bomb Type EX 17 Mod. 0 Lot 5, Serial No. 18. Fragments recovered from NPG Water Pit represent 1/6 of total expected in zone 60°-120°.

Figure 19

Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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Fragmentation Tests of Notched-Ring Bombs, 250 lb.,
Type Ex 17 Mod 0

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